INFLUENCE OF NONAGRICULTURAL

VALUES ON AGRICULTURAL

LAND PRICES

By

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PAPER I

RECREATIONAL AND URBAN INFLUENCES ON AGRICULTURAL LAND VALUES

Introduction

Agricultural land has many uses, including agricultural production, recreation and potentially urban conversion. In some areas, the primary value of agricultural land is its potential to be converted to commercial or residential uses. While it is known that agricultural land prices have generally increased over time, the determining factors contributing to the increases are less well known. Land prices in rural Oklahoma are reportedly increasing at dramatic rates, even in areas of low agricultural productivity. Demand for land for recreational uses and "ranchettes," rather than farm or ranch expansion, may be driving forces. Agricultural producers question whether selling property and relocating would help them capture appreciation in land values in a local market and lower their opportunity cost on the land investment. It is not known how widespread land price appreciation has been within the state nor is it known what factors are most important in different geographic regions.

Recreational opportunities such as hunting, fishing, bird watching and photography are varied in Oklahoma because of the quantity and diversity of natural resources. Utilizing farmland for recreational purposes may be no more than allowing hunters to hunt on the same tract that cattle graze, resulting in two income streams, one from the hunting lease and the other from the cattle. An agricultural credit survey of bankers in the Kansas City District found a 10 percent increase in recreational demand for agricultural land in 2003; investment and recreation were the top two reasons for agricultural land purchases in 2002 and 2003 (Henderson and Novack 2005).

Analysis of agricultural land prices is important because rates of change are not uniform and prices are affected by different factors in different geographic regions. While it is important to understand why land prices have changed historically, it is also important to understand how the prices are changing currently and what factors are affecting current prices. The information obtained from this research will enable not only producers, but also lenders, appraisers, realtors, and public citizens to understand the importance of recreational uses on agricultural land values. This study determines the relative importance of agricultural, recreational, and urban conversion values in determining Oklahoma agricultural land prices. The relative importance of these factors on cropland and pasture land prices is considered. The procedure used is hedonic regression models, estimated using land price sales data.

Theory

Historically, U.S. land prices have increased with a few dips in the 1930s and 1980s (Colyer 2004). In January 2006, the average U.S. farmland price, including land and buildings, was $1,900 per acre (Williams and Hintzman 2006). The U.S. average for cropland values increased 13 percent from the prior year to $2,390 per acre while Oklahoma cropland averaged $891 per acre, a 5.3 percent increase from 2005. The U.S.

and Oklahoma pasture values increased 22 and 18.8 percent, respectively, to $1,000 and $760 per acre. Although cropland values are higher than pasture values, recent historical data clearly shows a gain in nominal pasture values over cropland values.

Economic theory suggests that the value of land is derived from the net present value of future returns. Various theories have been used to explain agricultural land values, the most common being the capital asset pricing theory and the capitalization formula. As Morton (1970) argues, the capitalization theory has been used to explain the prices of land since the time of the classical economists such as David Hume, Adam Smith, David Ricardo, and J.S. Mill. The capitalization formula is:

(1) Agricultural land values = returns/discount rate.

The returns can be from agricultural uses, recreational uses or from urban conversion. Most previous studies have focused on agricultural returns to land and while these returns are still significant, the returns from recreation and urban conversion are likely increasing.

While other theoretical models have been considered, the capitalization formula is still the most commonly considered. Studies such as Barry (1980) and Chavas (1999) for example, approached agricultural land value research with a Capital Asset Pricing Model (CAPM). Clark (1993) argued that rational bubbles, risk aversion, and shifts in policy should be incorporated.

The importance of nonagricultural values has long been recognized. Walter (1946) noted that differences in the capitalization rate on various properties might be from non-agricultural or non-income producing activities. Bastian et al. (2002) suggests that competing market activities are causing agricultural land to be demanded by different input markets. Henderson and Moore (2005) as well as Bastian et al. (2002) found recreational purposes to be significant. Henderson and Moore (2005) found that agricultural land values were higher where hunting lease rates and recreation income was higher, concluding that recreation is impacting land values (Henderson and Moore 2005). Henderson and Novack (2005) found that non-farm purposes are driving land prices higher as evidenced by cropland cash rents increasing 15 percent, but cropland values increasing 32 percent over a seven year time period.   Agricultural factors such as soil productivity, land productivity, land improvements, tract size, cash rents, per capita income, government payments, interest rates, and farm income were also common variables (Bastian et al. 2002; Huang et al. 2006; Henderson and Moore 2005; Falk 1998; Moss 1997; Burt 1986; Flanders 2004). Other variables such as population density, population growth, and distance to urban areas are used by Bastian et al. (2002), Henderson and Moore (2005) and Huang et al. (2006) to determine possible effects on agricultural land values. Recreation variables have included hunting lease rates, deer density, recreational income from agricultural uses, and acres of elk habitat (Bastian et al. 2002; Henderson and Moore 2005). Bastian et al. (2002), Falk (1998), Moss (1997), Burt (1986), and Flanders (2004) use time series data for land price per acre; Huang et al. (2006) and Henderson and Moore (2005) use cross sectional data.

This study further explores the importance of nonagricultural influences in determining land values. Hedonic regressions are used as in most past studies. We include variables to explain agricultural land values with potential returns deriving from agriculture, recreation, and urban sprawl. Total deer harvest and recreational income from agricultural uses account for the effect of recreational returns on land value while population density, population growth, and per capita income account for the urban effect.

Procedures

The hedonic pricing model used in this research specifies agricultural land prices as a function of land characteristics. Past research has used either county-level data or parcel level data. The multi-level data set used here includes both county-level data and characteristics of the parcel. Three models are estimated, each having successively more explanatory variables. The first model considers only agricultural influences as it includes the land use acreages, rainfall, a dummy variable for year and random effects for the county variable. The second model adds variables for recreation income, deer density, population and income to measure potential returns from nonagricultural uses. The third model includes interaction terms to allow the nonagricultural variables to have different effects on pasture land and cropland. All models use 2001 to 2005 data. The first model is

$$\begin{aligned} y_{itp} &= \beta_{ot} + \beta_{1t}ACRES_{itp} + \beta_{2t}ACRES2_{itp} + \beta_{3t}PCROP_{itp} + \beta_{4t}PIRRIG_{itp} + \\ &\beta_{5t}PTIMBER_{itp} + \beta_{6t}PWASTE_{itp} + \beta_{7t}PRECREATION_{itp} + \beta_{8t}PWATER_{itp} + \\ &\beta_{9t}RAIN_{it} + \varepsilon_{itp} \end{aligned} \tag{2}$$

where the dependent variable y is the agricultural land price per acre, i represents the individual county, t is the time period, and p is the parcel of land. The explanatory variables are total acres (*ACRES*), total acres squared (*ACRES2*), proportion (or percent) of the parcel devoted to each land use (*PCROP*, *PIRRIG*, *PTIMBER*, *PWASTE*, *PRECREATION*, and *PWATER*), and average county rainfall (*RAIN*). Percent of pasture acres and the year 2005 were not included to avoid perfect collinearity. The variables are defined in Table I-1. This model provides estimates of statewide average land price per acre adjusted only for parcel size and rainfall.

The second model with additional variables for nonagricultural uses is

$$\begin{aligned} y_{itp} = {} & \beta_{ot} + \beta_{1t}ACRES_{itp} + \beta_{2t}ACRES2_{itp} + \beta_{3t}PCROP_{itp} + \beta_{4t}PIRRIG_{itp} + \\ & \beta_{5t}PTIMBER_{itp} + \beta_{6t}PWASTE_{itp} + \beta_{7t}PRECREATION_{itp} + \\ & \beta_{8t}PWATER_{itp} + \beta_{9t}RAIN_{i} + \beta_{10t}RECINCOME_{it} + \beta_{11t}INCOME_{it} + \\ & \beta_{12t}POPDENSITY_{it} + \beta_{13t}POPGROW_{it} + \beta_{14t}DEER_{it} + \varepsilon_{itp}. \end{aligned} \tag{3}$$

The additional variables include recreation income divided by county acres (*RECINCOME*), county per capita income (*INCOME*), county population divided by county acres (*POPDENSITY*), population growth (*POPGROW*), and county deer harvest divided by county acres (*DEER*).

The last model includes all the previously defined variables and adds interaction terms, including recreation income (*RECINCCI*), deer density (*DEERCI*), population density (*POPDENCI*), population growth (*POPGRCI*), livestock cattle prices (*CATTLECI*), and income (*INCOMECI*). All were interacted with percentage of cropland acres plus the percentage of irrigated cropland acres. The crop returns variable was interacted with the percent of cropland acres (*RETC*). The third model lets characteristics such as deer harvest have different effects on cropland and pasture land prices.

$$\begin{aligned} y_{itp} = {} & \beta_{ot} + \beta_{1t}ACRES_{itp} + \beta_{2t}ACRES2_{itp} + \beta_{3t}PCROP_{itp} + \beta_{4t}PIRRIG_{itp} + \\ & \beta_{5t}PTIMBER_{itp} + \beta_{6t}PWASTE_{itp} + \beta_{7t}PRECREATION_{itp} + \beta_{8t}PWATER_{itp} + \\ & \beta_{9t}RAIN_{it} + \beta_{10t}RETC_{it} + \beta_{11t}CATTLECI_{it} + \beta_{12t}DEER_{it} + \beta_{13t}DEERCI_{it} + \\ & \beta_{14t}RECINCCI_{it} + \beta_{15t}RECINCOME_{it} + \beta_{16t}INCOMECI_{it} + \beta_{17t}INCOME_{it} + \\ & \beta_{18t}POPDENCI_{it} + \beta_{19t}POPDENSITY_{it} + \beta_{20t}POPGRCI_{it} + \beta_{21t}POPGROW_{it} + \varepsilon_{itp}. \end{aligned} \tag{4}$$

The full data set plus two subsets of the data are used to estimate the three models: all acres, less than eighty acres and greater than or equal to eighty acres. Misspecification tests were conducted to test for normality and outliers. Plots of the residuals showed a number of outliers. Many of the outliers on land value per acre were in Tulsa and Oklahoma counties and so all data from these counties were deleted due to their urban influence. A maximum of $3,000 per acre was set to exclude observations presumed to be non-agricultural tracts. A minimum of $150 per acre was specified because prices that are too low may represent transactions among related individuals below market value.

Graphs of cropland and pasture land price per acre over the five year period were created to illustrate average cropland and pasture land values per acre with the adjustments made in the third model. Cropland prices, for example, were obtained by setting the percentage of cropland to one and setting all other variables to their statewide mean for each year. The crop and pasture land prices were then plotted over the five year period for each of the three data sets (Figure I-1, I-2, I-3).

Data

The data include sales price of agricultural land for the time period of 2001-2005 for a total of 7,225 observations. Farm Credit Services offices in Oklahoma have collected data for many variables for all 77 counties in Oklahoma including the dependent variable, land price per acre, and the independent variables of county location, sales date and land use separated into pasture, cropland, timber, waste, irrigated cropland, recreation land use, and areas of water. Percent of water acres describes wet areas, lakes, and any other body of water included in the land sales transaction. These wet areas have potential recreation uses, but little or no agricultural value. The land use variables are specified as percentage use. Total acres per sales transaction were also used as a variable. The data included rental income of recreational uses such as hunting leases but because of concerns about its completeness it was not used. The value for improvement contribution, as estimated by the appraiser, was subtracted from the net sale price to account for house, building, and other improvement values. The acres used by the improvements were also deducted in calculating the price per acre.

The remaining variables were collected as secondary data from various sources with data for each of the 77 counties in Oklahoma. The Oklahoma Climatological Survey website lists average monthly rainfall amount in inches for each county based on precipitation for 1971-2000. In this research, rainfall is an average for the county developed from this data and the same number was used for 2001-2005. Rainfall is a proxy for farm yield potential. Annual livestock cattle prices were collected from the Livestock Marketing Information Center for 2001-2005. The weekly cattle prices for 600-700 lb steers at the Oklahoma City auction were used to calculate an average annual price. The prices were lagged to allow the previous year's cattle prices to affect the current year's land values.

The crop returns above operating costs variable was calculated using NASS, Oklahoma State Farm Service Agency (FSA), and Oklahoma State University enterprise budget (OSU) data. The production by commodity for each county for 2001 to 2005 (NASS) was multiplied by a county level crop price. The county crop price for a given year was estimated by multiplying the state price (NASS) by the ratio of the county loan rate (for all commodities except cotton and peanuts) to the national loan rate (FSA). The county loan rates for cotton were obtained from a personal contact (Jay Cowert) and the Plains Cotton Cooperative Association. The peanut loan rate was obtained from a personal contact (Larry Vance) with The Clint William's Company. This crop revenue value for the county was then divided by the total harvested acres for the commodity in the county. Operating cost of production (OSU) was subtracted from the crop revenue per harvested acre to acquire a revenue per acre figure. The costs by year were calculated by taking the prices paid index (Jen Brown, NASS) and dividing the current year index by the 2005 index and multiplying that number by the total costs for a given commodity. The revenues for dryland and irrigated were weighted separately by the total number of harvested acres for each commodity in each county for each year (NASS). The commodities included in this calculation for other commodities were dryland barley, alfalfa hay, soybeans, grain sorghum, wheat, and oats plus non-irrigated and irrigated cotton, corn, and peanuts.

Total population estimates and per capita income by county for the years 2001-2005 were obtained from the U.S. Department of Commerce, Bureau of Economic Analysis. The population data were used to create population growth and population density variables. Total per capita income is recorded in thousands of dollars.

Deer harvest data were obtained from the Oklahoma Wildlife Commission and included the total number of deer harvested for 2001-2005 by county. Recreational income from agricultural uses, recorded in thousands of dollars, was collected from the USDA 2002 Agricultural Census data and applied to 2001 through 2005. There were eleven counties with missing values to avoid disclosing individual data. An average of the neighboring counties was calculated for the missing values. Deer harvest, population, and recreational income were divided by total county acres (Census Bureau) to obtain a more accurate measure of potential returns per acre. Descriptive statistics for variables are given in Table I-1. The average land price per acre was $848.49 and average total acres on a tract were 231. Average per capita income for the 77 counties was $22,068. These land prices are higher than those reported by USDA. The USDA data is based on survey data and survey respondents may be underestimating land values.

Results

In the first model, the percent of crop, timber, irrigated cropland, recreation, and water variables are expected to be significant and have positive signs. The percent of waste acre variable is expected to have a negative sign. The coefficients on the percent of irrigated cropland acres are expected to be larger than the coefficients on the percent of cropland acres for all data sets as irrigated land should have higher returns for agricultural land. The recreational land use variables, percent of recreation and percent of water acres are also hypothesized to positively affect land values.

As cropland acres have historically yielded greater returns per acre, tract size might be expected to have a positive impact on land values if the land will be used for farm expansion. However, large tract sizes might not be an asset for other purposes. For instance, smaller acreages may have more potential buyers. Hence, no prior hypothesis was made about the sign of the acres variable. Rain is used as a proxy for yield potential and thus higher rainfall areas are expected to have higher land values.

The parameter estimates for the first model are shown in Table I-2. Irrigated farmland is the highest valued land use. Cropland has a small premium relative to pasture on the large tracts, but is less valued than pasture on small tracts. Prices decrease with tract size, but at a decreasing rate as the coefficient on the squared term is negative. Rain is positive and significant for all data sets except the smaller tracts. Smaller tract sizes are not as likely to be used for agricultural purposes. The percent of recreation and water variable proved to be not as influential as expected. Neither was significant for any of the data sets, but few observations were recorded with these primary land uses.

The basic model with only agricultural variables tells us that pasture land is relatively more valuable in smaller tract sizes. Recreational purposes and urban conversion may be the driving force since pasture land is the most popular choice for hunting and if it has some trees, it is preferred for conversion to residential uses.

The second model (Table I-3) includes the recreational variables, deer density and recreation income, which are expected to have positive signs. Urban influence variables (annual per capita income, population density and population growth by county) are also included in this model and are expected to have positive signs. Percent of cropland and irrigated cropland are expected to be positive and significant.

As illustrated in Table I-3, the deer harvest variable is positive and significant for all tract sizes and the coefficient is largest on small tract sizes. Recreation income is not significant for any of the data sets and was also negative for the two larger tract size data sets. The urban variables, income, population density, and population growth, were positive and significant for all data sets. The positive significance of the population density and population growth variables is consistent with other studies such as Henderson and Moore (2005).

The first and second model are similar in that percent of irrigated cropland is positive for all data sets and percent of cropland is only positive for the greater than or equal to eighty acres. The results show the rain variable as positive and significant for all data sets. The value decreases as the tract size increases which can be explained by the same reasons as in the first model, smaller tract sizes demanded for nonagricultural purposes.

The third model includes the interaction terms, which allows us to look at the variables a little differently. The parameter estimates are shown in Table I-4. The land use variables, percent of cropland and percent of irrigated cropland, are positive and significant. Percent of timber and waste variables are negative and significant while percent of recreation and water are insignificant. The rain variable results are consistent with the second model in that the variable is positive and significant for all tract sizes.

The interaction terms help to explain how cropland and pasture land prices are affected. The crop returns interaction terms were expected to be positive while the cattle prices interaction term was expected to be negative since it was interacted with farmland, not pasture. The deer interaction with percent of cropland was also expected to be negative since most hunting probably takes place on pasture.

The results are consistent with the results from the first two models in that agricultural uses are important on larger tracts. The crop returns interaction was positive and significant for all data sets and the coefficient decreased as the tract size decreased, although the decreases were slight. The cattle prices interaction had the expected sign and was significant for the two larger tract sizes. The deer interaction term was negative, but significant at the 10% probability level for only the all acres data set.

The interaction terms for income, population density, and population growth were all significant. The income and population growth interactions were negative for all data sets. Only the recreational income interaction term was significant at the 5% probability level for the greater than or equal to eighty acres data set.

The elasticities are shown in Table I-5. The rain and cattle prices have the largest elasticities. Therefore, if rainfall increases by ten percent, land values would increase by $74 per acre while a ten percent increase in cattle prices would cause a $67 per acre increase. Ten percent increases in population density or per capita income would increase values by $15 and $66 per acre, respectively. The deer harvest elasticity is 0.11, just slightly less than population density. We can conclude that agricultural and urban influences dominate over other influences. The agricultural and urban variables have the largest elasticities, ranging from 0.74 for rainfall to 0.15 for population density. Recreational income and crop returns have a negative elasticity. This is due to the negative coefficient in the model.

Figure I-1 shows the graphs of cropland and pasture land price per acre for all parcels, Figure I-2 for parcels greater than or equal to eighty acres, and Figure I-3 for parcels less than eighty acres. These figures reflect the cropland and pasture land price per acre when adjusted for recreation and urban effects. For all tract sizes, pasture land shows a premium over cropland values. For larger tract sizes, cropland and pasture land prices are almost the same until 2004 where pasture land values begins increasing more rapidly than cropland. These results are important as they show that the finding of pasture and cropland prices being similar is not due simply to more of the pasture being in highly populated areas. The prices per acre for the larger tract sizes are relatively smaller than the other two data sets. The smaller tract sizes show pasture land as more valuable and the prices per acre range from around $900 to $1350 per acre. This tells us that the smaller tract sizes, especially for pasture, are demanded more for uses other than agriculture. The larger tracts, which are thought to be used for agricultural purposes, have prices per acre more in accordance with agricultural use value. As shown in the figures, overall results indicate pasture land values exceed cropland values. This may be attributed to the record high cattle prices and/or increasing urban conversions of agricultural land.

Conclusion

The focus of the study was to determine the impacts of agricultural, recreational, and urban conversion values on Oklahoma land values. This was accomplished by estimating three models with successively larger numbers of variables. Deer harvest and recreational income variables were included to capture the recreational impact on land values. Although recreational income was often insignificant, the positive significant coefficients on the deer harvest variable supports the idea that recreation uses are an important component of land values. The urban influence also becomes apparent when variables for income, population density, and population growth are added to the model. Income, population density, and population growth consistently register positive and significant impacts for all data sets.

Comparing the three varying tract sizes in the study, it can be concluded that for most tract sizes in the dataset, larger tract sizes decrease the per acre land value and are particularly negative for tracts within the less than eighty acres data set. Tract size affects how the land will be used which is why tract size is important in how the land is valued.

Residential or commercial uses would demand smaller sizes where an agricultural producer looking to expand might prefer a larger tract size.

The study included limitations due to the limited recreational data. Measuring recreational activities is difficult and surveys on the subject are inconsistent or are nationwide studies rather than county level. The limitations emphasize the importance of gathering accurate data such as hunting lease rates, which would enable research to become more precise. Agricultural land purchases are made by investors, agricultural producers, and those demanding land for recreational uses, which causes the value of the land to be important to them and others such as lenders, appraisers, and realtors. When reviewing past and recent literature, certain variables (land productivity, interest rates, and cash rents) are common in the majority of the models. Although these variables are important, the more recent literature indicates an increase in recreation, urban effects, and other non-farm uses impacting agricultural land values. This study confirms that agricultural factors impact agricultural land values, but non-farm uses such as recreation are increasingly influential.

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Table I-1. Variable Names and Descriptive Statistics

Variable	Units	Mean	SD	Min	Max
Land sales price (*PERACRE)*	$/a	848.49	486.91	150.0[a]	3000.0[a]
Total deeded acres (*ACRES*)	a	230.72	652.9	2.0	14,384.0
Crop acres (*PCROP*)	%	22.1	0.356	0	100.0
Irrigated crop acres (*PIRRIG*)	%	0.8	0.078	0	100.0
Timber acres (*PTIMBER*)	%	12.1	0.244	0	100.0
Waste acres (*PWASTE*)	%	0.3	0.021	0	44.00
Recreation acres (*PRECREATION*)	%	0.0067	0.006	0	50.0
Water acres (*PWATER*)	%	0.07	0.016	0	100.0
Deer harvest/county acres (*DEER*)	deer/a	0.002	0.001	8.9E-5	0.008
Per capita income/county (*INCOME*)	$/person	22,068.04	2,785.84	15,664.0	31,170.0
Average county rainfall (*RAIN*)	inches	38.28	7.42	17.2	53.6
Recreation income (*RECINCOME*)	$1,000/a	0.003	0.009	0	0.07
Crop returns (dryland) (*RETC*)	$/a	85.76	41.63	-24.63	214.79
Cattle prices	$/cwt	102.17	9.8	91.33	120.82
Population density (*POPDENSITY*)	#/a	0.058	0.056	0.002	0.64
Population growth (*POPGROWTH*)	%	0.046	1.2	-4.87	14.11

[a]Minimum and maximum price per acre set to delete outliers.

Table I-2. Estimates of the Hedonic Model with Only Agricultural Variables

Dependent Variable: Land price per acre

Variable	All acres	>= 80 acres	< 80 acres
INTERCEPT	447.93*** (37.9505)	293.17*** (32.0517)	1992.88*** (88.5918)
ACRES	-33.2459*** (1.7116)	-15.7797*** (1.3437)	-1587.54*** (241.26)
ACRES2	0.2703*** (0.01779)	0.1233*** (0.01378)	519.26** (228.29)
PCROP	-132.68*** (17.1665)	8.1385 (14.3163)	-127.66*** (33.7576)
PIRRIG	372.14*** (66.1278)	498.02*** (50.9811)	187.48 (206.48)
PTIMBER	-396.11*** (22.7726)	-323.16*** (20.6703)	-319.84*** (38.6238)
PWASTE	-1330.91*** (244.21)	-1007.33*** (192.84)	-1310.36*** (455.54)
PRECREATION	408.47 (868.27)	741.74 (655.69)	278.55 (962.86)
PWATER	-346.25 (309.08)	-84.3917 (249.86)	-129.20 (877.88)
RAIN	17.9312*** (0.8605)	17.6098*** (0.7607)	1.6535 (1.6477)
YEAR 2001	-299.07*** (16.6243)	-270.79*** (14.2824)	-317.44*** (30.4319)
YEAR 2002	-243.58*** (16.7084)	-227.47*** (14.3458)	-258.85*** (30.7718)
YEAR 2003	-180.97*** (15.9964)	-199.19*** (13.8905)	-171.15*** (28.9082)
YEAR 2004	-100.43*** (16.0121)	-111.07*** (13.9817)	-101.69*** (28.3476)

Table I-3. Estimates of the Model with Variables Representing Recreational and Urban Conversion Uses

Dependent variable: Land price per acre

Variable	All acres	>= 80 acres	< 80 acres
INTERCEPT	-31.9456	168.66***	771.26***
	(68.1889)	(56.6147)	(147.89)
ACRES	-27.8827***	-12.9835***	-1758.64***
	(1.5655)	(1.2128)	(220.92)
ACRES2	0.2285***	0.1037***	766.37***
	(0.01623)	(0.01241)	(208.92)
PCROP	-45.2718***	67.8202***	-36.3118
	(16.1131)	(13.2253)	(32.0134)
PIRRIG	515.80***	573.33***	452.33***
	(60.2130)	(45.8358)	(188.57)
PTIMBER	-343.09***	-268.27***	298.6***
	(20.8070)	(18.7048)	(35.2497)
PWASTE	-1223.80***	-949.28***	-962.63***
	(221.84)	(173.14)	(414.84)
PRECREATION	227.71	601.31	77.9149
	(788.82)	(588.78)	(876.61)
PWATER	-258.13	42.7553	-488.18
	(280.76)	(224.41)	(798.99)
RAIN	15.1870***	11.4414***	8.4966***
	(0.9004)	(0.8103)	(1.6987)
YEAR 2001	-258.15***	-243.51***	-269.19***
	(15.8728)	(13.4968)	(28.9489)
YEAR 2002	-216.27***	-210.71***	-222.43***
	(15.7289)	(13.3464)	(29.1318)
YEAR 2003	-180.54***	-194.98***	-181.06***
	(14.7304)	(12.5965)	(27.1807)
YEAR 2004	-111.31***	-107.62***	-126.11***
	(14.5903)	(12.5732)	(26.0371)
DEER	36,100.0***	36,136.0***	45,002.0***
	(4,548.0)	(4,129.75)	(7,702.51)
RECINCOME	-137.23	-153.63	860.74
	(524.28)	(451.51)	(1,022.22)
INCOME	0.0147***	0.00515***	0.02976***
	(0.002185)	(0.001802)	(0.004272)
POPDENSITY	2,507.2***	2,403.6***	1,865.49***
	(96.0361)	(90.5930)	(146.38)
POPGROWTH	3,842.28***	2750.13***	6,112.58***
	(417.18)	337.17	(956.08)

Table I-4. Estimates of the Hedonic Model with Interaction Terms

Dependent Variable: Land price per acre

Variable	All acres	>= 80 acres	< 80 acres
INTERCEPT	-315.86***	81.0665	501.21***
	(85.0855)	(72.6079)	(170.04)
ACRES	-27.7731***	-12.9690***	-1,771.61***
	(1.5573)	(1.2042)	(220.38)
ACRES2	0.2267***	0.027***	788.06***
	(0.01613)	(0.01232)	(208.46)
PCROP	1,267.39***	975.59***	1,394.0***
	(183.2)	(148.03)	(377.87)
PIRRIG	1,984.21***	1,644.65***	2,100.23***
	(200.55)	(160.89)	(447.31)
PTIMBER	-337.95***	-263.71***	-290.56***
	(20.7754)	(18.71)	(35.1429)
PWASTE	-1,164.99***	-974.74***	-906.67**
	(221.63)	(172.83)	(414.35)
PRECREATION	113.07	530.51	-33.8623
	(783.71)	(583.93)	(873.23)
PWATER	-263.77	25.4482	-478.75
	(278.88)	(222.50)	(795.63)
RAIN	16.6951***	11.8159***	9.3528***
	(0.947)	(0.8474)	(1.7748)
YEAR 2001	-258.33***	-251.62***	-262.34***
	(17.1188)	(14.8125)	(30.4155)
YEAR 2002	-225.01***	-225.05***	-216.27***
	(16.6749)	(14.3216)	(30.4044)
YEAR 2003	-195.39***	-220.85***	-174.41***
	(17.2687)	(15.3209)	(30.1041)
YEAR 2004	-127.76***	-127.89***	-128.53***
	(15.5747)	(13.6219)	(27.1303)
RETC	2.0735***	1.916***	1.7201**
	(0.3111)	(0.2414)	(0.7904)
CATTLECI	-4.1031***	-4.2586***	-3.9241
	(1.213)	(1.1256)	(2.7495)
DEER	39,900.0***	3,5447.0***	50,832.0***
	(4,874.63)	(4,496.74)	(8,041.06)
DEERCI	-23,812.0*	11,238.0	33,023.0
	(14,093.0)	(11,709.0)	(28,475.0)
RECINCOME	-250.79	-265.16	1,018.47
	(553.39)	(483.42)	(1,050.2)
RECINCCI	-2,794.26	-3,845.79**	-1,668.84
	(2,297.02)	(1,807.69)	(5,441.5)
INCOME	0.02558***	0.009914***	0.04039***
	(0.002811)	(0.002407)	(0.005103)

Table I-4. Estimates of the Hedonic Model with Interaction Terms (continued)

Dependent Variable: Land price per acre

Variable	All acres	>= 80 acres	< 80 acres
INCOMECI	-0.04762***	-0.03135***	-0.05233***
	(0.005907)	(0.004775)	(0.01196)
POPDENSITY	2,240.49***	2,136.68***	-1,669.53***
	(105.53)	(102.48)	(154.13)
POPDENCI	1,209.52***	1,236.67***	1,709.58***
	(332.89)	(280.03)	(641.14)
POPGROW	4,942.59**	3550.73***	4921.0***
	(574.82)	(488.01)	(1104.0)
POPGRCI	-4218.24***	-3076.74***	2,396.21***
	(1116.73)	(904.65)	(2,863.19)

*denotes significance levels: *** 1% probability, ** 5% probability, * 10% probability

Table I-5. Elasticities for the Hedonic Model with Interaction Terms

Variable	Elasticity
Rainfall	0.74
Cattle prices	0.675
Per capita income	0.664
Population density	0.152
Deer harvest	0.114
Population growth	0.0026
Crop returns	-0.0024
Recreational income	-0.00096

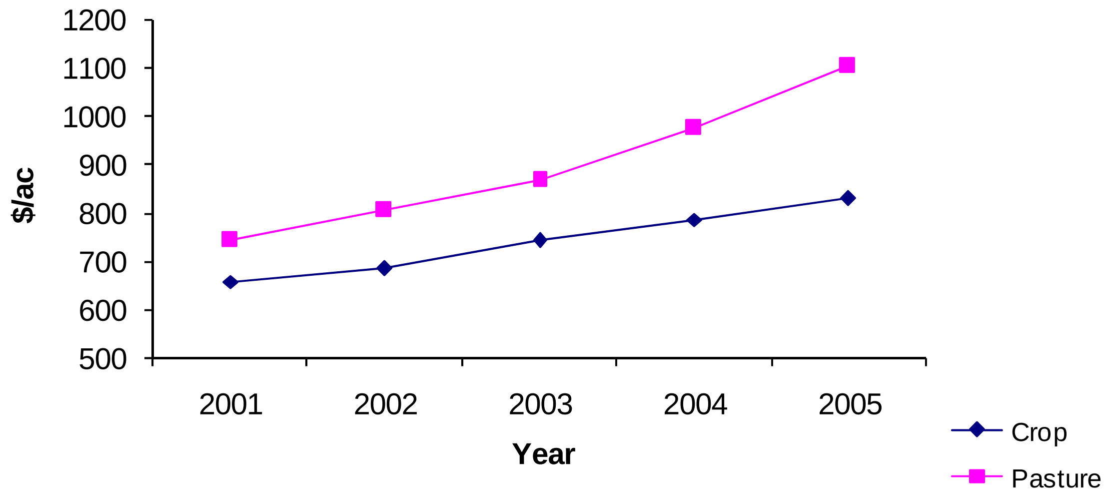

Figure I-1 Cropland and Pasture Land Price per Acre for All Parcels

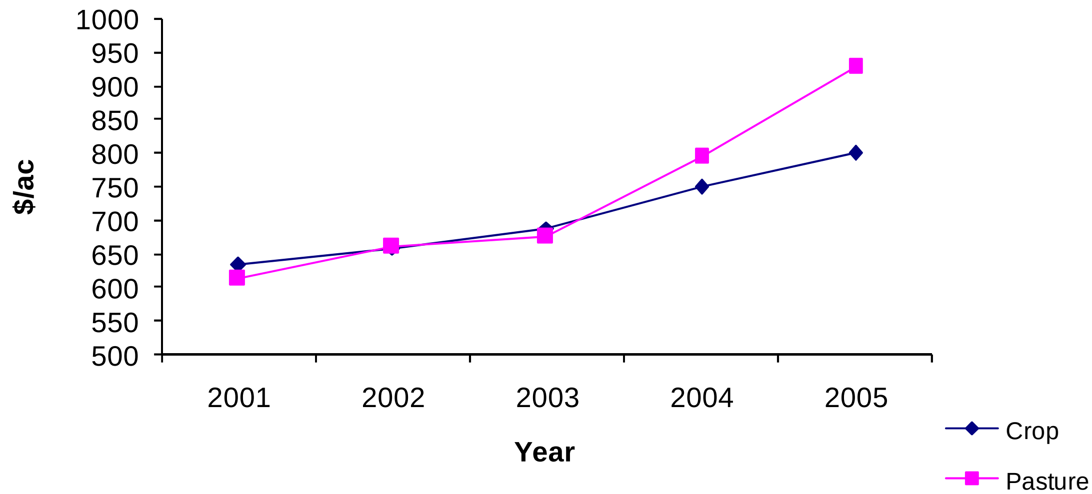

Figure I-2. Cropland and Pasture Land Price per Acre for Parcels Greater Than or Equal to Eighty Acres

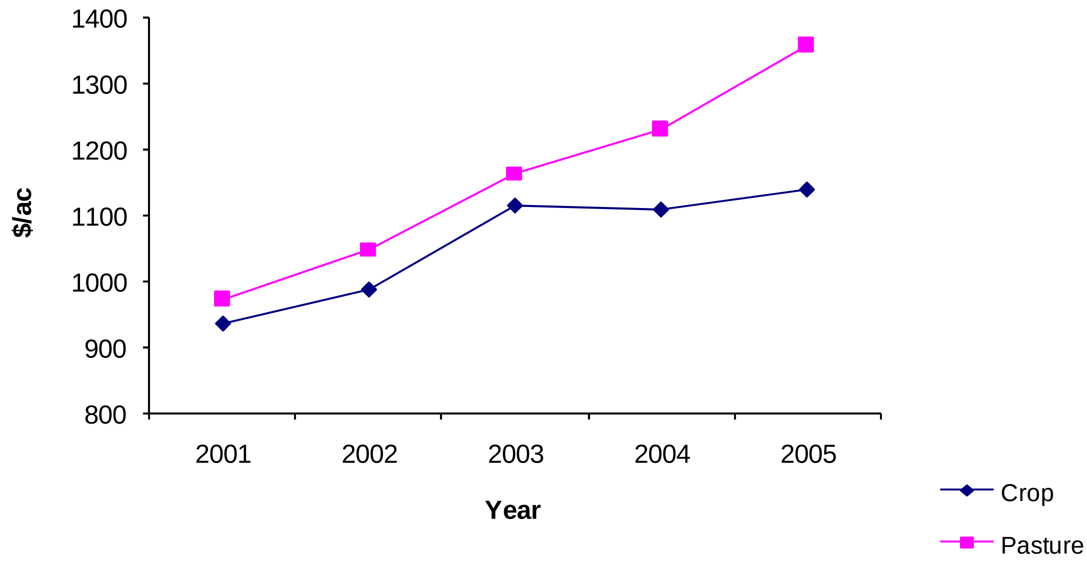

Figure I-3 Cropland and Pasture Land Price per Acre for Parcels Less Than Eighty Acres

PAPER II

CROP VERSUS PASTURE LAND PRICES

Introduction

The factors determining agricultural land values have been studied extensively. Most studies focus on explaining agricultural land values over time. Others use county-level cross-section time-series data to explain land prices over time and space. Some studies use data on sales of individual land parcels to determine the value of land characteristics. Here, we try to explain the differences in the value of cropland relative to pasture land over time and space. The data used are individual transactions over a 34-year period, which allows analyses that would not be possible with the data used in most studies.

This study determines how the value of cropland relative to pasture varies across regions of Oklahoma. Cropland rental rates have historically been much higher than pasture rental rates. Yet, we find much smaller differences in the value of cropland relative to pasture. Such a finding suggests that the income approach to appraising agricultural land is likely not useful.

Differences in cropland and pasture land are unique for Oklahoma due to the geographic locations in which each is located. The state seems to be separated in half where one side is predominantly crop and the other is pasture. This allows us the advantage in observing each region while focusing on various factors and how they help to explain the cropland and pasture land prices. The information obtained from this research will enable not only appraisers, but also lenders, producers, realtors, and public citizens to understand changes in cropland and pasture land prices.

Theory

Economic theory suggests that the value of land is derived from the net present value of future returns. Barry (1980) and Chavas (1999) approached agricultural land value research with a Capital Asset Pricing Model. Clark (1993) argued that rational bubbles, risk aversion, and shifts in policy should be incorporated. As Morton (1970) notes, the capitalization theory has been used to explain the price of land since the time of classical economists such as David Hume, Adam Smith, David Ricardo, and J.S. Mill. While other theoretical models have been considered, the capitalization formula is still the most commonly applied:

(1) Agricultural land values = returns/discount rate.

The returns can be from agricultural uses, recreational uses or from urban influences. Most previous studies have focused on agricultural returns to land and while these returns are still significant, the returns from recreation and urban conversion are increasing.

Farm income can come from crops, livestock, government payments, and rent. Leistritz et al. (1985) included expected gross income from crops while Awokuse and Duke (2004) and Obi and Schalkwyk (2006) included net returns in their studies. Flanders et al. (2004) studied rental rates as an independent variable for cropland and pasture land finding that cash rents are not a significant factor in determining agricultural land values.

Government payments have long been studied with interesting results. Janssen and Button (2004) found government payments influential for cropland values and rents; however, land productivity had a larger effect than government payments due to policy changes in the farm programs. Flanders et al. (2004) found that government payments influenced cropland values and crop rents, but had less effect on pasture land values and rents as pasture land is not part of farm programs. Henderson and Moore (2005) included government payments in their study and found the variable insignificant, explained by the inclusion of a crop receipts variable causing collinearity. Government payments and crop returns are included in this study although the crop returns are calculated in a way that does not include government payments, therefore reducing the problem of collinearity.

The cost of production should be considered and can include land, machinery, equipment, labor, feed, and equipment (Colyer 2004). Herdt and Cochrane (1966) included a ratio of prices received to prices paid indices in a study of how technological advances influence land prices. The results show that agricultural land values and farm income increase with technological advances. Other agricultural factors such as land improvements and tract size were common variables (Bastian et al. 2002; Huang et al. 2006; Henderson and Moore 2005; Falk et al. 1998; Moss 1997; Burt 1986; Flanders et al. 2004; Obi and Schalkwyk 2006).

Variables such as per capita income, population density, population growth, and/or distance to urban areas were used by Bastian et al. (2002), Henderson and Moore (2005), Huang et al. (2006), Blasé and Hesemann (1973), McLaren and Henning (2004), and Herdt and Cochrane (1966) to determine possible urban effects on agricultural land values.

Many studies have relied solely on surveys, whereas others have used census and USDA survey data for the dependent and some independent variables (Flanders et al. 2004; Henderson and Moore 2005; Janssen and Button 2004; Leistritz et al. 1985; Blasé and Hesemann 1973; McLaren and Henning 2004; Burt 1986). One exception is Huang et al. (2006), who obtained land sales information from transfer declarations data filed with the Illinois Department of Revenue, but they still aggregated prices to the county level. The current study uses actual sales transaction data with sales price per acre calculated by dividing the parcel sales value by the number of acres in the parcel.

The current study focuses on differences in cropland and pasture land values, a common practice in previous research. Leistritz et al. (1985), Blasé and Hesemann (1973), and McLaren and Henning (2004) included cropland and pasture land acres or production as a variable. Janssen and Button (2004), Huang, et al. (2006), and Herdt and Cochrane (1966) included a land productivity variable that proved to be an important factor in determining land values. This study further explores the changes in cropland and pasture land prices by addressing the structural changes over time. Hedonic regressions are used as in most past studies.

Procedures

The hedonic pricing model used specifies agricultural land prices as a function of land characteristics, namely factors associated with agriculture, recreation, and urban values. The multi-level data set includes both county-level data and characteristics of the parcel. Two models are estimated for western and eastern regions in Oklahoma using 1972 to 2005 data. A four year moving average was taken for crop returns, government payments, and cattle prices. Because of the four year moving averages for the three variables, the estimation only uses land price data from 1974 to 2005.

The model includes the land use variables percent of cropland (*PCROP*), percent of irrigated cropland (*PIRRIG*), and percent of other land which includes timber, waste, water, and recreation acres (*POTHER*). Crop returns for dryland and irrigated cropland were interacted with percent of cropland (*RETC*) and percent of irrigated cropland (*RETI*), respectively. Government payments were also interacted with percent of cropland (*GOVC*) and percent of irrigated cropland (*GOVI*). Cattle prices were interacted with percent of cropland plus percent of irrigated cropland (*CATTLECI*). The variables average rainfall (*RAIN*), deer (*DEER*), per capita income (*INCOME*), and population density (*POPDENSITY*) were included along with interaction terms for percent of crop plus percent of irrigated with deer (*DEERCI*), per capita income (*INCOMECI*), and population density (*POPDENCI*). Dummy variables are created for the year variables for the statewide model. The intercept can be interpreted as the percent of pasture. The model is

$$\begin{aligned} y_{itp} = {} & \beta_{oit} + \beta_{1t} ACRES_{itp} + \beta_{2t} ACRES2_{itp} + \beta_{3t} PCROP_{itp} + \beta_{4t} PIRRIG_{itp} + \\ & \beta_{5t} POTHER_{itp} + \beta_{6t} RETC_{itp} + \beta_{7t} RETI_{it} + \beta_{8t} GOVC_{it} + \beta_{9t} GOVI_{it} + \\ & \beta_{10t} CATTLECI_{it} + \beta_{11t} RAIN_{i} + \beta_{12t} DEER_{it} + \beta_{13t} DEERCI_{it} + \beta_{14t} INCOME_{it} + \\ & \beta_{15t} INCOMECI_{it} + \beta_{16t} POPDENSITY_{it} + \beta_{17t} POPDENCI_{it} + \varepsilon_{itp}. \end{aligned} \tag{2}$$

where the dependent variable *y* is the agricultural land price per acre, *i* represents the individual county, *t* is the time period, and *p* is the parcel of land. The explanatory variables are defined in Table II-1.

The data set used to estimate the models included tracts containing eighty or more acres since we are primarily interested in agricultural values and smaller tracts are often used for nonagricultural purposes. A maximum of $3,000 per acre was set to exclude observations presumed to be non-agricultural tracts. A minimum of $50 per acre was specified because prices that are too low may represent transactions among related individuals below market value. Tulsa and Oklahoma counties were removed to eliminate the urban influences. Data on any parcel within fifteen miles of Oklahoma's twelve largest urban areas was excluded to reduce urban influences from major urban areas.

Data

Farm Credit Services offices in Oklahoma have collected data for many variables for all 77 (only 75 used) counties in Oklahoma including the dependent variable, land price per acre, and the independent variables of county location, sales date and land use separated into pasture, cropland, timber, waste, irrigated cropland, recreation land use, and areas of water. The cropland acres are assumed to be dryland acres. The land use variables are specified as a percentage of the total acres. Total acres per sales transaction is also a variable used in the model. The value for improvement contribution was subtracted from the net sale price to account for house, building, and other improvement values. The acres used by the improvements were also deducted in calculating the price per acre.

The remaining variables were collected as secondary data from various sources with data for each of the seventy-seven counties in Oklahoma. The state is partitioned into two regions, western and eastern regions. Eight regions were originally delineated by Dr. Darrel Kletke, professor emeritus of agricultural economics at Oklahoma State University, who had previously conducted agricultural land analyses for Oklahoma land sales. Using those eight regions, we were able to separate the state into a western and an eastern region. The eastern region is mostly pasture land while the western is predominantly cropland. Annual cattle prices were collected from various issues of the USDA Economic Research Service Red Meats Yearbook for 1972-2005. The weekly cattle prices for 600-700 lb steers were used to calculate an average annual price.

The crop returns above operating costs variable was calculated using NASS, Oklahoma State Farm Service Agency (FSA), and Oklahoma State University enterprise budget (OSU) data. The production by commodity for each county for 1971 to 2005 (NASS) was multiplied by a county level crop price. The county crop price for a given year was estimated by multiplying the state price (NASS) by the ratio of the county loan rate (for all commodities except cotton and peanuts) to the national loan rate (FSA). The county loan rates for cotton were obtained from a personal contact (Jay Cowert) and the Plains Cotton Cooperative Association. The peanut loan rate was obtained from a personal contact (Larry Vance) with The Clint William's Company. Per acre crop income was estimated using the higher of the county crop price or loan rate. This crop revenue value for the county was then divided by the total harvested acres for the commodity in the county. Per acre operating cost of production (OSU) was subtracted from the crop revenue per harvested acre to acquire a net income above operating cost per acre figure. The per acre costs by year were calculated by dividing the current year prices paid index (Jen Brown, NASS) by the 2005 index and multiplying that number by the 2005 total costs for a given commodity. The revenues for dryland and irrigated cropland were weighted separately by the total number of harvested acres for each commodity in each county for each year (NASS). The commodities included in this calculation for other commodities were dryland barley, alfalfa hay, soybeans, grain sorghum, wheat, and oats plus non-irrigated and irrigated cotton, corn, and peanuts. Figures were calculated for 1971 but as there were missing data for irrigated cropland for 1971, all 1971 observations were removed.

The land sales data contained a legal description that included section, township, and range. Legal description data for the state of Oklahoma were obtained from the Oklahoma Natural Resources and Conservation Services (NRCS) version of the Public Land Survey System (PLSS). The land sales legal descriptions were linked to the PLSS legal description ArcView shape files. Distances were measured from the center of the sales transaction legal descriptions to the urban centers using the most direct route along a network road system. Distance was measured in meters (converted to miles) for each transaction so that parcels within fifteen miles of one of the twelve largest urban areas could be removed from the data set.

Total population estimates by county, total per capita income and total government payments, in thousands of dollars, by county for the years 1972-2005 were obtained from the Bureau of Economic Analysis. The population data were used to create population growth and population density variables. The population by county was divided by total county acres (Census Bureau). Government payments were divided by base acres for all program commodities, which were obtained from FSA.

Deer harvest data were obtained from the Oklahoma Wildlife Commission and included the total number of deer harvested for 1972-2005 by county. The deer harvest was divided by total county acres to obtain a more accurate measure of potential returns per acre. Descriptive statistics for variables are given in Table II-1.

Results

The expected results for the regional model were that the total transaction acres would be negative because as the parcel size decreases the per acre land value increases, though the impact of parcel size is smaller when land use is for agricultural purposes. Rainfall, crop returns for both dryland and irrigated acres, deer harvest, population density, and income were expected to be significant and positive. The deer harvest interacted with percent of crop plus percent of irrigated was expected to be negative since deer hunters prefer pasture over cropland.

The model was expected to show differences with the west reflecting a premium for cropland and the eastern region a premium for pasture. Other differences in the two regions such as population density and rain were also expected to be significant. Irrigated cropland commands a premium in any part of the state, since there is a substantial cost in installing irrigation equipment and land leveling.

The crop returns interaction variable was expected to be positive and significant for both regions. For the western region, crop returns interacted with irrigated land is negative and significant and the crop returns interaction with cropland is insignificant. The crop returns interaction with percent of cropland for the eastern region was positive and significant while the crop returns interaction with percent of irrigated land is insignificant. The negative sign and insignificance of the interaction terms for crop returns are extremely unexpected since the majority of studies find a positive and significant correlation between returns and land prices. A possibility for the results is an inadequate representation of cattle production returns in the model.

Government payment interaction terms with percent of cropland and irrigated cropland are insignificant in the eastern region, but are significant in the western region. The eastern region does not receive as much government payments due to the majority of the land being in pasture, which helps explain the results. The cattle prices interaction term is positive and significant for the western region, which may indicate that land is used for cattle more in the western region even though the majority of the pasture is in the east. Since the variable is interacted with percent of cropland and irrigated land, it was originally thought that the sign would be negative. However, in Oklahoma, most cropland is planted in wheat which is grazed during the winter and thus high cattle prices may increase cropland values.

The population density variable and its interaction term are positive and significant for both regions indicating that an increase in population results in an increase in pasture land prices. Income and its interaction term were only significant for the western region. The interaction terms for income and population density are only significant for the western region. Population in the western region is typically less than in the eastern region which would make an increase more influential. The deer interaction term with percent of cropland plus percent of irrigated cropland is negative and significant for both eastern and western Oklahoma. The negative sign is expected since hunting would take place on pasture land instead of cropland or irrigated cropland. The deer variable is only positive and significant for the eastern region. Although the eastern region has more pasture, an increase in the deer harvest will have a stronger impact in the western region. The population density differences from one region to the next may also help explain the results.

Historically, U.S. land prices have increased with a few dips in the 1930s and 1980s (Colyer 2004). In January 2006, the average U.S. farmland price, including land and buildings, was $1,900 per acre (Williams and Hintzman 2006). From 2005 to 2006, the U.S. average for cropland values increased 13 percent to $2,390 per acre while Oklahoma cropland increased 5.3% to an average of $891 per acre. The U.S. and Oklahoma pasture values increased 22 and 18.8 percent, respectively, to $1,000 and $760 per acre. Although cropland values are typically higher than pasture values, recent historical data clearly shows a more rapid rate of gain in pasture values than cropland values.

Figure II-1 and II-2 are graphs of estimated cropland and pasture land prices per acre over time. The cropland prices per acre, for example, were obtained by setting the percentage of cropland to one and setting all other variables to their statewide mean for each year. This was done for cropland and pasture land for each region. The western region shows a premium for cropland for the entire period. The gap between the cropland and pasture land prices though has slowly been narrowing. In 2005, the difference between the two was only $109 per acre. The eastern region reflects a premium for pasture land for the last ten years. The large dip in 1995 may be attributed to the slim number of observations for that year. These results are interesting in that pasture land is showing such a large price per acre. Urban conversion values and recreational influences are a probable cause and the results for the most recent years are not reflecting a true agricultural value for cropland and pasture land.

Figure II-3 and II-4 show the total crop returns above operating costs per acre for dryland and irrigated cropland over time. Figure II-5 shows land sales price per acre over time. By these illustrations, we can see the negative correlation among crop returns and land prices. Crop returns may be negatively correlated with some missing explanatory variables such as oil and gas royalty income. Error checks were conducted to ensure accuracy of the crop returns calculations. Also note the similarities between Figure II-3 and Figure II-5. The peaks were in the same year, 1981, as were the lows in 1987.

Conclusion

The purpose of this study was to explain the relative differences in cropland and pasture land values for the state over a 34 year time period. The state was divided into two regions to represent the differences in production, cropland and pasture land. Urban and recreation variables at the county level were used in a multi-regression model with sales price per acre as the dependent variable. Land uses at the parcel level, such as cropland, irrigated land, and other (timber, waste, recreation, water), were also used as explanatory variables. Pasture land was interpreted as the intercept.

Our results indicate an increase in pasture land prices relative to cropland prices when adjusted for agricultural, recreational, and urban influences. The differences in the two regions also reflect differences in cropland and pasture land prices. The western region indicated premiums for cropland and the graph illustrated this until the mid

1990's. The eastern region clearly showed a premium for pasture land as shown by the results and the graph.

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Table II-1. Variable Names and Descriptive Statistics

Variable	Units	Mean	SD	Min	Max
Land sales price (*PERACRE)*	$/a	541.18	325.98	50.0[a]	3,000.0[a]
Total deeded acres (*ACRES*)	a	246.0	579.62	80.0	36,364.0
Crop acres (*PCROP*)	%	34.6	0.384	0	100.0
Irrigated crop acres (*PIRRIG*)	%	1.3	0.1022	0	100.0
Other acres (*POTHER*)	%	3.44	0.1244	0	100.0
Rain (*RAIN*)	in	35.42	7.95	17.2	53.6
Deer harvest/county acres (*DEER*)	deer/a	0.00109	0.0012	0	0.00841
Per capita income/county (*INCOME*)	$/person	13,910.76	5,863.13	2,343.0	31,1707.0
Population density (*POPDENSITY*)	#/a	0.049	0.0482	0.0025	0.644
Crop returns (dryland)	$/a	70.36	55.92	-24.63	346.04
Crop returns (irrigated)	$/a	139.25	132.73	-66.77	663.35
Government payments	$/base a	0.0466	0.0897	0	1.302
Cattle prices	$/cwt	79.97	19.41	32.98	120.18

[a]Minimum and maximum price per acre set to delete outliers.

Table II-2. Estimates of the Hedonic Models for Western and Eastern Regions

Dependent Variable: Land price per acre

Variable	Western Region	Eastern Region
INTERCEPT	-88.79	562.90***
	(126.08)	(175.9)
ACRES	-10.2289***	-6.0212***
	(0.7417)	(0.4029)
ACRES2	0.08014***	0.02216***
	(0.007808)	(0.002244)
PCROP	465.44***	81.2373
	(21.4121)	(58.9343)
PIRRIG	658.59***	132.42
	(32.5397)	(322.27)
POTHER	104.48***	-257.59***
	(20.6104)	(12.9805)
RAIN	12.2899***	5.4045
	(3.7644)	(3.5672)
RETI	-0.1906**	1.129
	(0.07629)	(1.372)
RETC	-0.08509	1.117***
	(0.06221)	(0.3318)
GOVI	3219.22***	9762.48
	(744.94)	(7335.28)
GOVC	-1257.36***	-39.6252
	(353.08)	(254.26)
CATTLECI	1.3063***	1.3898
	(0.4428)	(0.9819)
DEER	-18354.0***	4396.58
	(6743.85)	(3954.35)
DEERCI	-55392.0***	-91559***
	(8028.96)	(10939.0)
INCOME	0.01667***	0.000316
	(0.001660)	(0.003376)
INCOMECI	-0.01609***	0.000091
	(0.001622)	(0.003825)
POPDENSITY	1730.5***	4096.95***
	(142.31)	(330.89)
POPDENCI	788.29***	431.68**
	(91.2022)	(242.48)
1974	-228.19***	-649.33***
	(34.67)	(62.1975)
1975	-203.79***	-640.14***
	(34.1624)	(61.272)
1976	-162.24***	-645.95***
	(33.9471)	(59.9556)

Table II-2. Estimates of the Hedonic Models for Western and Eastern Region (continued)

Dependent Variable: Land price per acre

Variable	Western Region	Eastern Region
1977	-144.49***	-580.15***
	(34.1041)	(58.9491)
1978	-80.5632**	-528.15***
	(32.4652)	(56.957)
1979	11.8661	-489.89***
	(29.332)	(54.2661)
1980	103.22***	-439.13***
	(28.8199)	(51.8011
1981	155.27***	-412.24***
	(26.5842)	(48.7196)
1982	80.4241***	-411.67***
	(25.3014)	(47.4371)
1983	-5.8308	-429.45***
	(25.9751)	(46.8239)
1984	-81.6188***	-438.55***
	(24.6109)	(44.4331)
1985	-224.94***	-543.75***
	(23.7775)	(43.0085)
1986	-327.64***	-606.05***
	(23.8935)	(42.1262)
1987	-350.96***	-672.57***
	(23.6306)	(41.8874)
1988	-342.19***	-676.96***
	(22.4309)	(39.4115)
1989	-307.8***	-672.78***
	(21.2261)	(36.6082)
1990	-302.83***	-658.32***
	(19.4912)	(34.4381)
1991	-332.39***	-647.42***
	(19.5626)	(32.8169)
1992	-301.78***	-627.94***
	(18.5865)	(30.679)
1993	-287.75***	-606.85***
	(17.7265)	(29.5527)
1994	-290.76***	-571.05***
	(17.7434)	(28.1092)
1995	-286.99***	-604.91***
	(21.6894)	(62.2276)
1996	-279.21***	-514.21***
	(19.7045)	(30.0138)

Table II-2. Estimates of the Hedonic Models for Western and Eastern Region (continued)

Dependent Variable: Land price per acre

Variable	Western Region	Eastern Region
1997	-280.06***	-513.25***
	(16.4633)	(23.4556)
1998	-254.24***	-435.61***
	(16.3724)	(21.8101)
1999	-257.16***	-417.0***
	(15.7095)	(19.8507)
2000	-221.67***	-351.36***
	(14.3658)	(16.9952)
2001	-194.64***	-325.98***
	(15.3053)	(16.2416)
2002	-190.08***	-253.8***
	(15.0929)	(15.8251)
2003	-155.56***	-218.72***
	(13.9114)	(15.2477)
2004	-85.3736***	-133.77***
	(14.0034)	(14.2579)

*denotes significance levels: *** 1% probability, ** 5% probability, * 10% probability

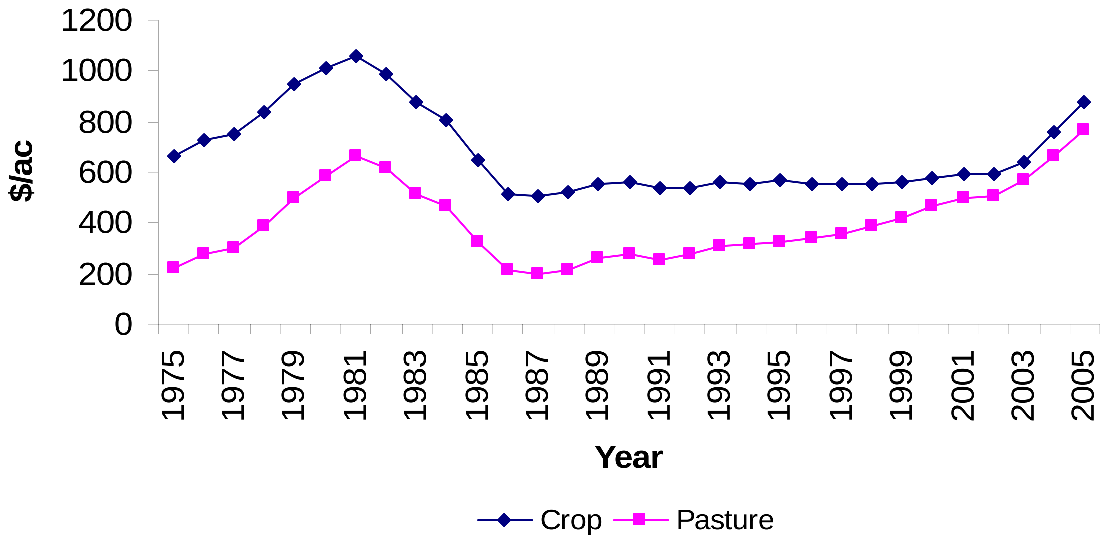

Figure II-1. Cropland and Pasture Land Price per Acre for the Western Region

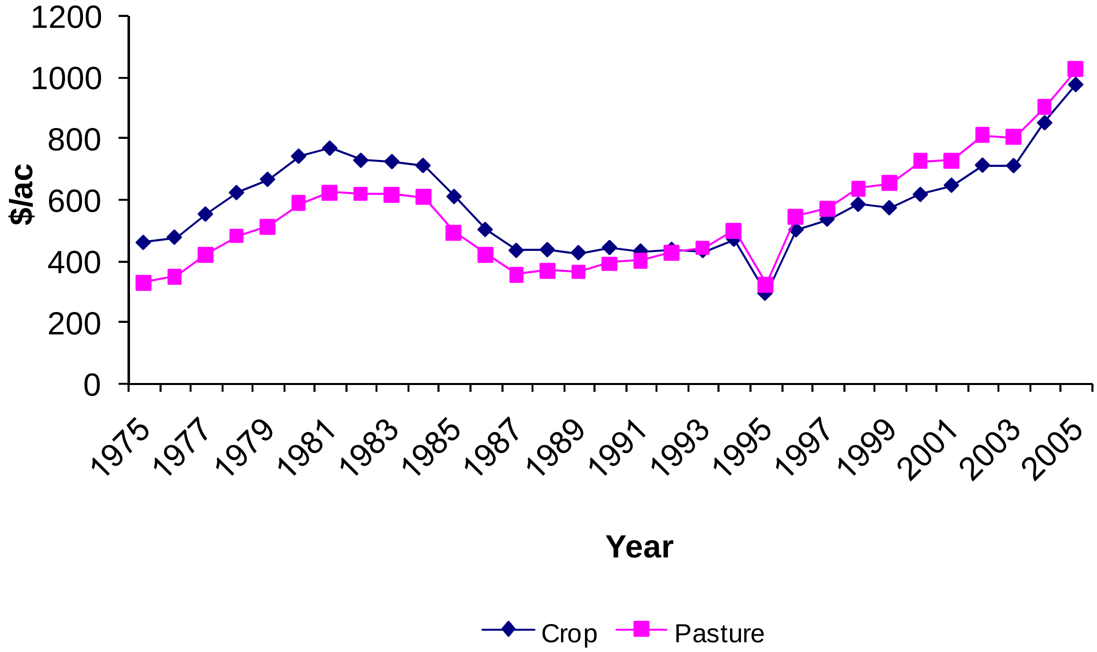

Figure II-2. Cropland and Pasture Land Price per Acre for the Eastern Region

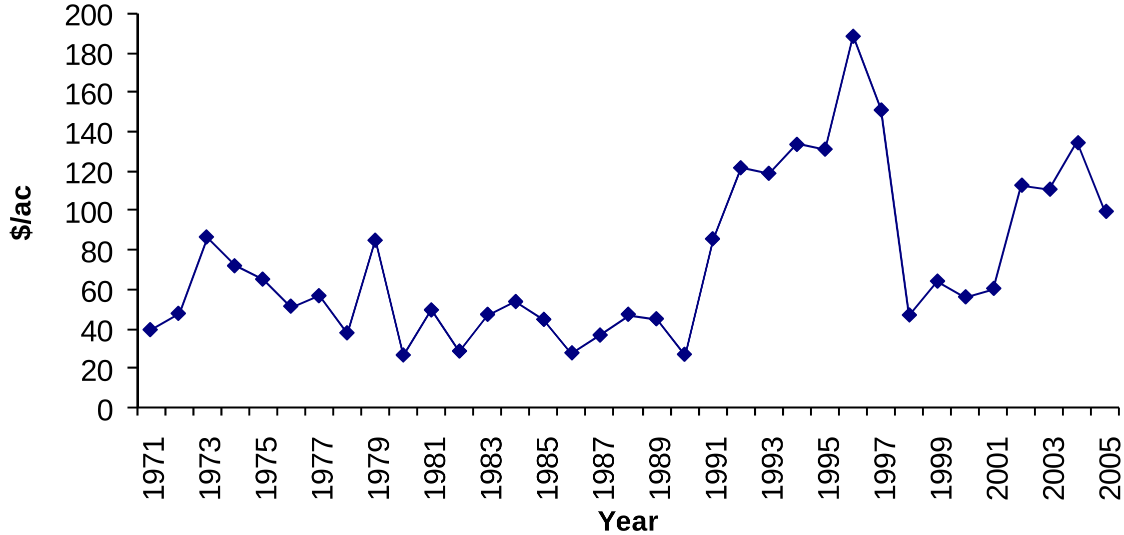

Figure II-3. Crop Returns per Acre for Dryland

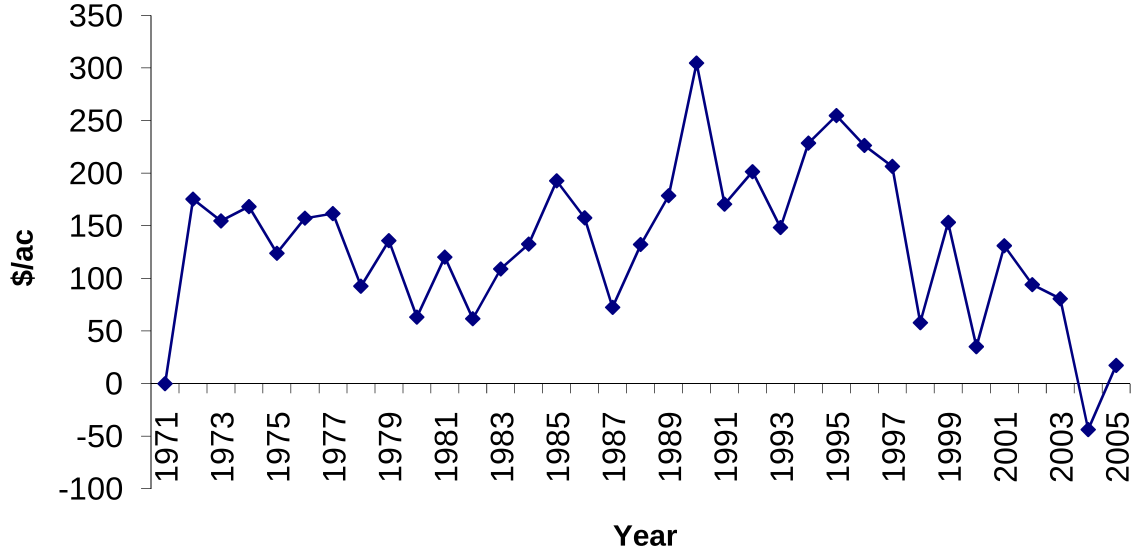

Figure II-4. Crop Returns per Acre for Irrigated Land

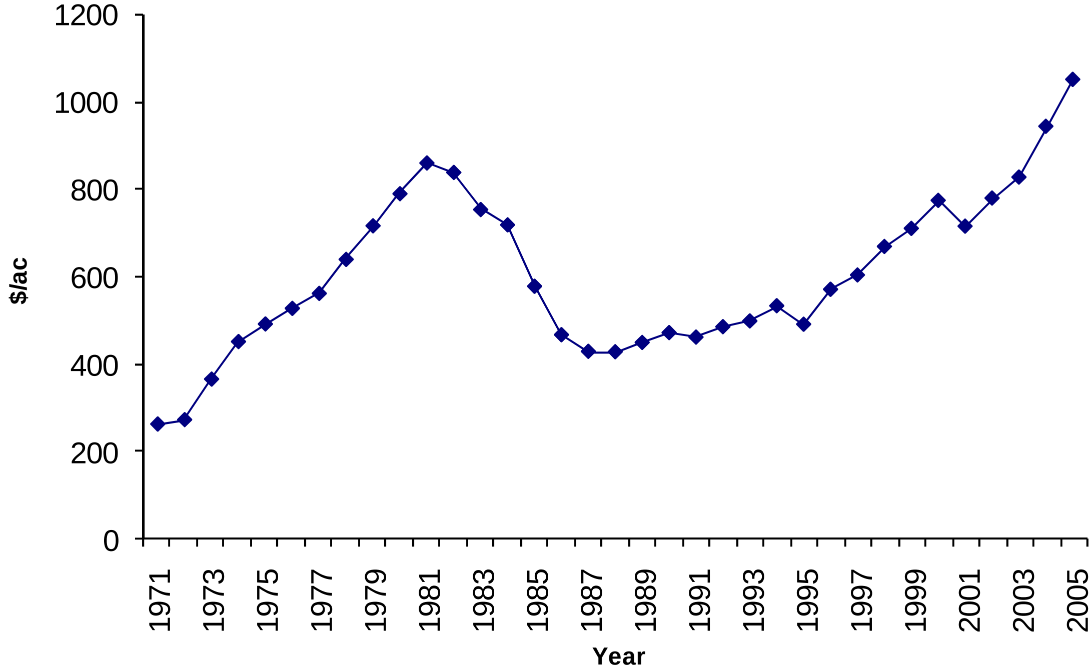

Figure II-5. Land Sales Price per Acre

PAPER III

URBAN EFFECTS

Introduction

Urban sprawl continues to be a concern of many communities. Efforts to discourage sprawl have included zoning, tax exemptions for agricultural use, and farmland preservation programs through which local governments or private organizations buy the land development rights. Open space clearly has a positive externality in residential areas as houses near open space sell at a higher price (Irwin and Bockstael 2001). Farmland also provides storm water management, wildlife habitat, and does not require substantial public services as do residential properties. Thus, urban sprawl may represent a market failure that justifies government intervention. The policies seeking to preserve farmland have led to a need to measure the urban conversion option values incorporated in agricultural land prices. This study estimates the effects of urban proximity on Oklahoma land sales over 1971-2005.

The available estimates of the effect of urban proximity on agricultural land value largely used county-level data rather than parcel data (eg. Plantinga and Miller 2001; Plantinga et al. 2002; Huang et al. 2006; Livanis et al. 2006). The use of county data has an advantage of being more widely available than parcel data (self-reported county land price data is available from the Census of Agriculture), but leads to imprecise measurement of urban effects. The USDA NASS prices are also lower than the prices we observe with our transaction price data, suggesting that survey data might lead to underestimation of both land prices and urban effects. Geographic information systems (GIS) that are now available make it possible to measure distances from a specific parcel to a specific city. The model used here extends the past research using county-level data by using a multilevel model incorporating both county-level data and parcel characteristics into a hedonic regression of land prices on characteristics. The multilevel model allows measuring the urban effect at the parcel level.

Livanis et al. (2006) note that the advent of geographic information systems (GIS) allows hedonic studies to be done with parcel-level data rather than county-level data. GIS measures of distance with parcel data are now relatively common in studies of residential property values (for example, Ready and Abdallah 2005; Irwin and Bockstael 2001) and some such studies have incredible detail and precision. Huang et al. (2006) used GIS data to measure the distance to Chicago and cities with population over 50,000 in a study of agricultural land prices. The use of GIS with parcel data to study agricultural land prices is relatively limited, presumably because realtors provide an easy source of house price data, but land price data is more difficult to obtain. An exception is a study by Bastian et al. (2002), but their focus was not on urban effects. Possibly because of the huge data acquisition costs, GIS hedonic studies using parcel data typically focus on a single community and thus cannot test hypotheses about why urban effects differ across communities nor can they incorporate county-level information when the area studied is a county or smaller area. Our approach of using data for an entire state allows us to test hypotheses about why the urban effect varies across communities and across time.

In addition, past studies have generally estimated the urban effect as a polynomial of distance or a step function using dummy variables or have truncated the urban effect. We use a linear spline function of distance that allows us to estimate the distance of the urban effect. The spline function estimates different parameters for the size of the effect and the distance of the effect and thus is a more flexible functional form than those used in past research.

The theory of the spatial size of cities (McGrath 2005) says that spatial size of cities is increasing in population and income and decreasing in transportation costs and agricultural rent. Empirical work has found little effect of transportation costs, but has strong support for the other variables (McGrath 2005). This leaves population and income to explain the urban effect on agricultural land values. In addition, we test whether the urban effect has increased over time. There is concern that urban sprawl is increasing over time beyond what would be expected from increases in population and income. In addition to zoning, taxing on agricultural value, and purchasing development rights, a number of other policies are available that might reduce urban sprawl (eg. increased gasoline taxes, urban renewal programs, and school vouchers).

Theory

Economic theory suggests that the value of land is derived from the net present value of future returns. While some authors (Barry 1980; Chavas 1999) used the capital asset pricing model to explain the theory behind agricultural land values, most authors use the capitalization formula. As Morton (1970, p. 250) argues even the classical economists (David Hume, Adam Smith, David Ricardo, J.S. Mill) used the capitalization theory to explain the price of land. The capitalization formula is:

(1) Agricultural land values = returns/discount rate.

The returns can be from agricultural uses, recreational uses or from the option to convert to urban uses. Most previous studies have focused on agricultural returns to land and while these returns are still significant, the returns from the urban conversion option are increasing.

Urban effects on agricultural land have been studied for many years. Questions have emerged regarding the nation's food supply being in jeopardy because of conversion of agricultural land and the importance of preserving farmland. Plaut's 1980 study of the effect of urbanization on agricultural land found little concern over the food supply and projected that by the year 2000, ten percent of the cropland base would be converted to urban uses.

Previous literature discusses decomposing farmland values into separate components. Plantinga and Miller (2001), Plantinga et al. (2002), Livanis et al. (2006), and Capozza and Helsley (1989) included agricultural rents and costs of converting agricultural land to urban uses in their studies of components of land price. Other variables included value of accessibility, value of expected future rent increases (Capozza and Helsley 1989) and distance to urban areas, population changes in urban areas, and interest rates (Plantinga and Miller 2001). By decomposing farmland values into components, Barton et al. (1980) studied the role of speculative behavior in farmland demand, where speculation is defined as farmland owners' tendency to purchase, sell, or hold land depending on its expected appreciation in value. The results indicate a direct relationship between the demand for farmland and the speculative behavior of market participants.

Decomposing land price components allows the effects of urbanization to be explained more accurately. Capozza and Helsley (1989) determined that given enough distance from an urban area, parcels are valued for agricultural uses only. The agricultural land price for a parcel jumps due to the cost of conversion at the edge of the urban area. Capozza and Helsley (1989) also state that a growth premium may account for half the average land price in rapidly growing cities. Livanis et al. (2006) find that urban proximity can also increase agricultural returns in addition to increasing urban conversion.

Nickerson and Lynch (2001) found purchase of development rights did not reduce land prices significantly and that larger parcels or parcels near currently preserved parcels are more likely to enter into preservation programs. Open space studies (Ready and Abdalla 2005; Irwin and Bockstael 2001) have focused on residential housing prices and the characteristics of open spaces. Ready and Abdalla (2005) found that both amenities of open space and disamenities of large scale animal or mushroom production affected surrounding house prices.

Previous studies measuring urban influences have included variables such as urban fringe (McLaren et al. 2004), distance to closest city with terminal market (Blasé and Hesemann, 1975), distances to major cities (Huang et al., 2006), adjacency to metropolitan counties (Henderson and Moore, 2005), distances to cities with transportation outlets, and distances to roads (gravel and paved). Carrion-Flores and

Irwin (2004) used distance measures by major road networks on parcel-level data to measure urban sprawl. Plantinga and Miller (2001) measured travel times from centers of counties to two metropolitan statistical areas and found land values are affected more as travel time and distance from the metropolitan areas decreases. Huang et al. (2006) and Henderson and Moore (2005) found that distances to urban areas were influential in determining agricultural land values with values declining as distance increased. McLaren et al.'s (2004) hedonic pricing model found that urban fringe and commercial influences plus the reason for the land purchase (residential, recreational, and farm use) positively influenced farmland values.

Procedures

Unlike past studies, the model used here can estimate the distance at which the urban influence on agricultural land values fades. The hedonic regression estimated is

$$\begin{aligned} \ln y_{itp} &= \beta_o + \beta_{1t} PCROP_{itp} + \beta_2 PIRRIG_{itp} + \beta_3 PPAST_{itp} + \beta_4 PTIMBER_{itp} + \\ &\beta_5 DEER_{itp} + \beta_6 ACRES_{itp} + \beta_7 ACRES2_{itp} + \beta_8 RAIN_i + \\ &\min\{a_{ct} + b_{ct} DISTANCE_{ct}, 0\} + \varepsilon_{itp}. \end{aligned} \tag{2}$$

where ln y is the dependent variable, natural log of land sales price per acre, i represents the individual county, c represents the twelve individual cities, p represents the land sales parcel, t is the time period, a represents the urban effect multiplier, and b represents the slope. Dummy variables were created for the year variable to capture the time trend leaving out the year 2005 to avoid perfect collinearity. The variables included in the model are percent of crop (PCROP), irrigated cropland (PIRRIG), pasture (PPAST), and timber (PTIMBER), total acres in the tract (ACRES), total acres squared (ACRES2), county rainfall (RAIN), deer harvest (DEER) and distance (DISTANCE) to the closest urban center.

The parameters of the spline function (a_{ct} and b_{ct}) are allowed to vary as a function of a time trend, population, and real income. The functional form is a linear plateau model like those used to model grain yield. Some urbanization and land value literature discusses the piecewise linear relationship between land prices and distance, but a linear spline function has not been used before, to our knowledge, in studying agricultural land values.

We define the *radius* as the distance from the city center where the urban effect dissipates, which is essentially when the agricultural land price is the state average price. Given any two of *a*, *b*, and *radius*, it is possible to solve for the third. Since the distance to the end of the urban effect (*radius*) is of interest, we estimate it rather than the slope (*b*). The urban effect multiplier, also estimated, is calculated as the exponential of a_{ct}. The formula where the urban effect is zero, which is the distance we are estimating with equation (2), is

(3) $$a + b(radius) = 0$$

which rearranges to

(4) $$b = -a/radius.$$

The equations used to define how a_{ct} and $radius_{ct}$ vary by city and time are

(5) $$a_{ct} = f_0 + f_1\sqrt{POPULATION_{ct}} + f_2 REALINCOME_{ct} + f_3 TIME_t$$

(6) $$radius_{ct} = g_0 + g_1\sqrt{POPULATION_{ct}} + g_2 REALINCOME_{ct} + g_3 TIME_t$$

where the coefficients, f and g, measure the effect of the variables, square root of population, real income, and time on a_{ct} and $radius_{ct}$. The term square root of population

($\sqrt{POPULATION_{ct}}$) was derived from the formula for area, $REALINCOME_{ct}$ is the real income of the urban center, and $TIME_t$ denotes the time trend. The parameters of the urban effect (a_{ct}, b_{ct}) are assumed to depend on the population and real income of the nearest city and are allowed to follow a linear time trend. Equations (5) and (6) were substituted into equation (2) and the parameters were estimated with nonlinear maximum likelihood.

The residuals of the regression are undoubtedly spatially autocorrelated. The inclusion of a county random effect likely captures a large portion of the spatial autocorrelation, but does not capture it all. The spatial autocorrelation will result in parameter estimates being inefficient and will cause significance levels to be overstated. With the large number of observations used here, this loss of efficiency is not a concern. Further, McCloskey and Ziliak (1997) argue that hypothesis tests should not be conducted with more than 30,000 observations anyway, since nearly every parameter will be statistically significant, so the overstatement of significance levels is also not a concern.

Data

The data include sales prices of agricultural land for the time period of 1971 to 2005 for a total of 45,879 observations. Farm Credit Services offices in Oklahoma have collected data for many variables for all seventy-seven counties in Oklahoma including the dependent variable, land price per acre. Also collected were county location, sales date and land use separated into pasture, cropland, timber, waste, irrigated cropland, recreation land use, and areas of water. The value for improvement contribution was subtracted from the net sale price to account for house, building, and other improvement values. The acres used by the improvements were also deducted in calculating the price per acre. A minimum of $150 per acre was specified for land values because prices that are too low may represent transactions among related individuals below market value. A maximum of $10,000 per acre eliminated true non-farm transactions, but also kept the agricultural observations that were possibly affected by urban influences.

The land sales data contained a legal description that included section, township, and range. Legal description data for the state of Oklahoma was obtained from the Oklahoma Natural Resources and Conservation Services (NRCS) version of the Public Land Survey System (PLSS). The land sales legal descriptions were linked to the PLSS legal description ArcView shape files. Distances were measured from the center of the sales transaction legal descriptions to the urban centers using the most direct route along a network road system. Distance was measured in meters (converted to miles) for each transaction for all thirty-five years of the data. Only land sales prices within 100 miles of one of the twelve cities were used.

The urban centers were chosen based on population. The urban centers included eleven towns in Oklahoma (Lawton, Oklahoma City, Tulsa, Ardmore, Bartlesville, Duncan, Enid, Muskogee, Ponca City, Shawnee, and Stillwater) and one in Arkansas, Fort Smith (Figure III-1). The population data used to choose the locations were based on the metropolitan and micropolitan statistical area figures. The populations ranged from 530,000 people in Oklahoma City to 22,000 people in Duncan. Metropolitan and micropolitan statistical areas were also used for the population estimates and per capita income for the twelve urban centers for the years 1971-2005 (Bureau of Economic

Analysis). The per capita income was deflated by the GDP deflator index to use real income in the model.

The Oklahoma Climatological Survey website lists average monthly rainfall amount in inches for each county based on precipitation for 1971-2000. In this research, rainfall is an average for the county developed from this data and the same number was used for 1971-2005. Deer harvest data were obtained from the Oklahoma Wildlife Commission and included the total number of deer harvested for 1971-2005 by county. The deer harvest was divided by total county acres to obtain a more accurate measure of potential returns per acre. Descriptive statistics are listed in Table III-1.

Results

The parameter estimates for the model are listed in Table III-2. The land use variables indicate that irrigated land is most valuable followed by crop, pasture, and timber. The coefficients for the parameters f_0, f_1, f_2, f_3, g_0, g_1, g_2, and g_3 are the parameters measuring the urban effect. The coefficient for f_1 measured the effect of the square root of population on the urban effect multiplier, f_2 measured the effect of real income on the multiplier, and f_3 measured the effect of time on the multiplier. The elasticity for the square root of population is 0.55, which means that a 10% increase in population results in a 5.5% increase in the urban effect multiplier where real income indicates a 4.2% increase and a 0.3% increase for time (Table III-3).

Table III-4 contains the urban effect multipliers, exp*(a)*, for each of the cities over time. We can see that Oklahoma City and Tulsa have the largest multipliers and also have the highest population. The multipliers for some cities vary minimally over time, which can be attributed to these cities having little change in population and real income.

The urban effect multiplier is specified for the center of the city, typically the location of the central post office. There is no urban effect on the price of agricultural land values when the multiplier equals one. We can conclude greater population and income increases the urban impact on agricultural land values. Agricultural land will not be found in the center of a city. The multiplier decreases as the distance from the city increases and the agricultural land will have a smaller multiplier than any number in the table. The multipliers show a gradual increase over time, which indicates that urban values are increasing relative to agricultural values.

Table III-5 shows the distances for all of the cities where urban influence ends. Oklahoma City and Tulsa had a distance in 2005 of 43 miles. Smaller cities such as Duncan, had a distance of 22 miles in 2005 which was a minimal change from 21 miles in 1971. The average distance for all the cities was 27.2 miles in 2005 (Figure III-2 and Table III-5). Although all the smaller cities had a decrease in distance, the decline is minimal.

The coefficients for g_1, g_2, and g_3 measured the effect of the square root of population, real income, and time on the distance where the urban effect ends. Since every city and town could not be considered, the urban effect ending means that the urban effect goes to the average for the rest of the state rather than going to zero. The elasticities for the *radius* indicate that real income is the main reason for increases in distance. A 10% increase in real income results in a 9.2% increase in distance from the city center to where the urban effect becomes the state average land price. The elasticity for the square root of population is 0.24 and –0.26 for time. The negative time elasticity for the *radius* indicate time does not have as much influence on the distance. Thus, there is no indication of any increasing preference to live farther from the city center except that resulting from increasing population and income. Table III-5 shows small increases in the distance of the urban effect. The importance of real income and population are the consistent with literature on the spatial size of cities (McGrath 2005).

Conclusion

Previous studies using hedonic pricing models determined that greater distances to urban centers decreased price per acre for agricultural land. This study finds similar results when Oklahoma agricultural land sales prices per acre are examined using distances to the center of the twelve cities with the largest population. The time period included thirty-five years. The size and distance of the urban effect were allowed to vary across city and time. Population and real income for the twelve urban areas were used to explain the changes in the urban effect across city and time. There were large differences across cities, but only small changes across time.

The average distance in 2005 where urban influence ends for agricultural land in Oklahoma has increased slightly due to increased population and real income. But, the evidence does not favor a shift in tastes and preferences toward living farther from the city center. Population and real income have varied over time, affecting urbanization and agricultural land values. Real income has the most effect on the distance of the urban effect, while population has the most influence on its size. Although Oklahoma is less populated than many other states, the urban influence is strong.

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Table III-1. Variable Names and Descriptive Statistics

Variable	Units	Mean	SD	Min	Max
Land sales price-log (L*PERACRE)*	$/a	6.35	0.595	5.01	9.21
Total deeded acres (*ACRES*)	a	179.53	452.03	1.0	36,364.0
Crop acres (*PCROP*)	%	0.2919	0.384	0	13.35
Irrigated crop acres (*PIRRIG*)	%	0.0084	0.0813	0	1.0
Pasture acres (*PPAST*)	%	0.6675	0.4513	0	16.0
Timber acres (*PTIMBER*)	%	0.0255	0.1375	0	5.0
Waste acres (*PWASTE*)	%	0.018	0.0904	0	1.1
Rain (*RAIN*)	in	37.522	6.578	23.8	53.6
Deer harvest/county acres (*DEER*)	deer/100a	0.131	0.131	0	0.8417
Ardmore	meters	23,9209.33	96,551.75	1,770.0	572808.0
Bartlesville	meters	242,860.42	112,178.37	3,256.0	860,794.0
Duncan	meters	226,216.22	102,529.4	4,834.0	650,274.0
Enid	meters	211,225.41	97,584.47	3,886.0	571,409.0
Fort Smith, AR	meters	315,541.72	121,061.27	7,155.0	911,754.0
Lawton	meters	232,249.17	109,168.17	2,087.0	674,901.0
Muskogee	meters	225,935.81	114,676.72	4,597.0	813,266.0
Oklahoma City	meters	170,111.69	68,838.22	11,008.0	400,602.0
Ponca City	meters	220,323.16	97,055.99	3,170.0	717,691.0
Shawnee	meters	172,708.14	66,341.9	2,807.0	475,093.0
Stillwater	meters	182,871.41	79,226.97	3,321.0	588,605.0
Tulsa	meters	202,082.86	99,433.89	13,082.0	735,802.0
Ardmore – Population	#	52,632.09	2,436.24	44,656.0	55,986.0
Bartlesville – Population	#	48,240.22	2,942.0	41,093.0	53,859.0
Duncan – Population	#	42,780.31	1,997.36	36,726.0	47,139.0
Enid – Population	#	59,287.13	3,063.17	56,486.0	67,597.0
Fort Smith, AR – Population	#	241,870.79	26,773.34	178,063.0	282,006.0
Lawton – Population	#	114,890.81	4,275.69	100,399.0	121,858.0

Table III-1. Variable Names and Descriptive Statistics (continued)

Variable	Units	Mean	SD	Min	Max
Muskogee – Population	#	68,239.48	2,468.61	59,996.0	70,692.0
Oklahoma City – Population	#	989,359.60	105,396.91	751,178.0	1,142,390.0
Ponca City – Population	#	48,969.64	1,486.63	46,802.0	53,113.0
Shawnee – Population	#	60,256.04	5,350.1	44,232.0	67,798.0
Stillwater – Population	#	64,006.36	3,916.62	52,808.0	69,707.0
Tulsa – Population	#	777,298.02	78,788.0	582,203.0	880,713.0
Ardmore – Income	$1,000/person	15,218.56	6,063.24	3,239.0	24,318.0
Bartlesville – Income	$1,000/person	20,360.51	6,967.16	4,991.0	30,498.0
Duncan – Income	$1,000/person	14,964.24	5,865.36	3,484.0	25,168.0
Enid – Income	$1,000/person	17,040.51	6,514.78	3,946.0	27,856.0
Fort Smith, AR – Income	$1,000/person	14,375.87	6,359.6	3,054.0	24,802.0
Lawton – Income	$1,000/person	15,027.95	6,492.73	3,349.0	2,6438.0
Muskogee – Income	$1,000/person	13,638.83	5,522.41	3,347.0	22,940.0
Oklahoma City – Income	$1,000/person	17,812.82	7,368.16	4,226.0	30,449.0
Ponca City – Income	$1,000/person	17,315.71	5,973.97	4,290.0	26,865.0
Shawnee – Income	$1,000/person	13,965.65	5,472.55	3,521.0	23,005.0
Stillwater – Income	$1,000/person	13,751.42	6,070.32	2,772.0	23,399.0
Tulsa – Income	$1,000/person	19,120.58	8,214.23	4,131.0	32,150.0
Distance	meters	66.055	35.039	1.77	159.99
Population		19860.9	30173.8	3672.6	114239.0
Square Root Population		36.84	25.07	19.16	106.88
Income		15.95	6.68	2.77	32.15
Real Income		19.6	3.85	9.58	30.64

.Table III-2. Parameter Estimates for the Linear Spline Function Model

Parameter	Estimate	SE	Parameter	Estimate	SE
Intercept	59.976	1.229	1996	-0.575	0.020
1971	-1.168	0.026	1997	-0.573	0.015
1972	-1.045	0.026	1998	-0.504	0.015
1973	-0.845	0.021	1999	-0.434	0.015
1974	-0.622	0.020	2000	-0.435	0.014
1975	-0.579	0.019	2001	-0.431	0.016
1976	-0.523	0.019	2002	-0.342	0.016
1977	-0.461	0.019	2003	-0.278	0.015
1978	-0.359	0.019	2004	-0.110	0.015
1979	-0.212	0.018	*PCROP*	0.576	0.0094
1980	-0.140	0.019	*PIRRIG*	1.262	0.026
1981	-0.060	0.019	*PPAST*	0.261	0.0072
1982	-0.097	0.019	*PTIMBER*	0.122	0.016
1983	-0.187	0.019	*DEER*	0.011	0.00039
1984	-0.274	0.018	*ACRES*	-27.361	0.648
1985	-0.467	0.018	*ACRES2*	1.099	0.039
1986	-0.684	0.017	*RAIN*	0.791	0.315
1987	-0.771	0.017	f_0	-0.060	0.654
1988	-0.791	0.017	f_1	1.293	0.047
1989	-0.753	0.016	f_2	1.805	0.444
1990	-0.722	0.016	f_3	0.145	0.159
1991	-0.753	0.016	g_0	42.208	0.548
1992	-0.692	0.016	g_1	29.368	0.149
1993	-0.686	0.015	g_2	206.515	0.598
1994	-0.645	0.016	g_3	-58.814	0.316
1995	-0.658	0.028	s_2	16.781	0.111

Table III-3. Elasticities for Population, Real Income and Time

Variable	Elasticities		
	Mean	Multiplier	Radius
Square Root of Population	36.84	0.56	0.25
Real Income	19.60	0.42	0.93
Time	20.00	0.03	-0.27

Table III-4. Urban Center Multiplier

Fort Smith, AR	Lawton	Oklahoma City	Tulsa	Ardmore	Bartlesville	Duncan	Enid	Muskogee	Ponca City	Shawnee	Stillwater
2.1	1.9	4.0	3.5	1.6	1.8	1.6	1.7	1.7	1.7	1.6	1.6
2.1	1.9	4.1	3.5	1.6	1.8	1.6	1.8	1.7	1.7	1.6	1.6
2.2	1.9	4.2	3.6	1.7	1.8	1.6	1.8	1.7	1.8	1.7	1.6
2.2	1.9	4.2	3.7	1.7	1.9	1.7	1.8	1.8	1.8	1.7	1.6
2.2	1.9	4.2	3.8	1.7	1.9	1.7	1.8	1.8	1.8	1.7	1.7
2.2	2.0	4.3	3.9	1.7	2.0	1.7	1.8	1.8	1.8	1.7	1.7
2.3	2.0	4.4	4.0	1.7	2.0	1.7	1.9	1.8	1.8	1.7	1.7
2.3	2.0	4.5	4.1	1.8	2.0	1.8	1.9	1.8	1.9	1.8	1.7
2.3	2.0	4.7	4.2	1.8	2.0	1.8	2.0	1.8	1.9	1.8	1.7
2.4	2.0	4.8	4.3	1.8	2.1	1.8	2.0	1.8	2.0	1.8	1.8
2.4	2.1	5.0	4.5	1.9	2.2	1.9	2.1	1.9	2.0	1.9	1.8
2.4	2.1	5.2	4.6	1.9	2.2	1.9	2.1	1.9	2.0	1.9	1.8
2.4	2.1	5.2	4.5	1.9	2.2	1.8	2.0	1.9	2.0	1.9	1.8
2.5	2.2	5.3	4.6	1.9	2.2	1.9	2.1	1.9	2.1	1.9	1.8
2.5	2.2	5.4	4.7	1.9	2.2	1.9	2.1	1.9	2.1	1.9	1.9
2.5	2.2	5.3	4.6	1.9	2.1	1.8	2.0	1.9	2.1	1.9	1.9
2.6	2.2	5.2	4.6	1.9	2.1	1.8	2.0	1.9	2.0	1.9	1.9
2.6	2.2	5.3	4.6	1.9	2.1	1.8	2.0	1.9	2.0	1.9	1.9
2.6	2.2	5.3	4.7	1.9	2.2	1.8	2.0	1.9	2.0	1.9	1.9
2.6	2.2	5.4	4.8	1.9	2.2	1.8	2.0	1.9	2.0	1.9	1.9
2.6	2.2	5.4	4.8	1.9	2.2	1.8	2.0	1.9	2.0	1.9	1.9
2.7	2.3	5.5	4.9	1.9	2.2	1.8	2.0	1.9	2.0	1.9	1.9
2.7	2.2	5.6	5.0	2.0	2.1	1.9	2.0	1.9	2.0	1.9	1.9
2.8	2.2	5.7	5.0	2.0	2.2	1.9	2.1	2.0	2.0	1.9	2.0
2.8	2.3	5.7	5.1	2.0	2.2	1.9	2.0	2.0	2.0	2.0	2.0
2.8	2.3	5.8	5.2	2.0	2.2	1.9	2.1	2.0	2.0	2.0	2.0
2.9	2.3	5.9	5.3	2.0	2.2	1.9	2.1	2.0	2.0	2.0	2.0
2.9	2.3	6.1	5.6	2.0	2.2	1.9	2.2	2.0	2.1	2.0	2.0
3.0	2.3	6.2	5.6	2.1	2.2	1.9	2.1	2.1	2.0	2.0	2.1
3.0	2.4	6.5	5.8	2.1	2.3	2.0	2.2	2.1	2.1	2.1	2.1
3.1	2.4	6.7	6.0	2.1	2.3	2.0	2.2	2.1	2.1	2.1	2.1
3.1	2.4	6.7	5.9	2.1	2.3	2.0	2.2	2.1	2.1	2.1	2.1
3.1	2.5	6.8	5.9	2.1	2.3	2.1	2.2	2.1	2.1	2.1	2.1
3.1	2.5	6.9	6.0	2.1	2.3	2.1	2.3	2.1	2.2	2.1	2.2
3.1	2.5	6.8	5.9	2.1	2.3	2.0	2.2	2.1	2.1	2.1	2.1

Table III-5. Distance in Miles to the End of the Urban Effect

Year	Fort Smith, AR	Lawton	Oklahoma City	Tulsa	Ardmore	Bartlesville	Duncan	Enid	Muskogee	Ponca City	Shawnee	Stillwater
1971	23.5	23.1	36.7	34.4	20.4	28.1	21.2	24.1	21.5	25.3	21.7	18.7
1972	23.8	23.4	37.1	34.8	20.6	28.0	21.7	24.4	21.8	25.2	21.6	18.5
1973	24.6	23.7	37.5	35.6	21.5	29.2	22.4	25.4	22.1	26.4	21.6	18.8
1974	24.5	23.6	37.7	36.6	21.6	30.5	23.0	25.2	22.7	27.0	21.4	18.8
1975	23.0	23.0	37.4	36.9	21.3	32.0	23.0	25.1	22.2	27.2	21.4	19.2
1976	24.6	23.2	37.7	37.4	21.4	32.9	23.3	25.4	22.7	26.4	21.5	19.3
1977	24.8	22.9	38.5	38.0	22.0	33.8	24.1	26.1	22.9	26.7	22.2	20.0
1978	25.2	22.9	39.4	38.8	22.5	34.8	24.5	26.5	22.4	26.8	22.9	20.3
1979	25.2	23.4	40.4	39.2	23.6	33.4	25.2	28.0	22.7	28.6	23.8	20.3
1980	25.2	23.8	41.5	40.3	24.9	34.5	25.9	29.2	22.7	29.5	24.3	20.5
1981	25.6	24.3	42.5	41.4	26.1	36.2	27.3	30.6	22.9	30.2	24.2	21.2
1982	24.9	24.7	43.0	41.2	25.6	36.5	26.6	30.1	22.6	31.3	23.7	21.3
1983	25.0	24.3	41.9	39.8	24.7	34.7	24.1	28.2	22.2	30.3	22.8	20.9
1984	25.8	25.7	42.4	40.3	25.1	34.6	24.5	29.4	22.4	32.9	23.2	21.2
1985	26.1	26.3	42.2	40.6	24.8	33.9	24.4	28.4	22.6	32.4	22.8	21.7
1986	26.3	26.1	40.9	39.6	23.5	31.9	22.1	26.9	22.1	31.1	21.9	21.2
1987	26.2	26.1	40.1	38.8	22.8	30.9	21.3	26.3	21.2	28.7	21.2	20.6
1988	26.3	25.3	40.1	39.2	22.9	31.7	22.0	27.0	20.8	27.8	21.5	20.5
1989	26.4	25.5	40.7	39.9	23.7	33.2	21.9	27.0	21.0	27.3	21.9	21.6
1990	26.2	25.2	40.4	40.7	23.9	33.5	21.7	26.8	20.7	27.5	21.4	21.6
1991	25.9	24.8	39.7	40.1	23.1	32.6	21.1	25.7	20.1	26.8	20.9	21.4
1992	26.8	25.3	40.2	40.7	23.2	32.5	20.8	25.7	20.2	27.1	21.1	21.4
1993	26.3	24.4	40.1	40.4	23.7	30.2	21.0	25.6	19.9	25.9	20.5	20.7
1994	27.0	23.8	40.3	40.2	22.8	30.2	20.5	25.3	20.3	25.2	20.9	20.9
1995	26.9	23.9	40.2	40.6	22.8	29.8	20.1	24.5	19.7	24.3	20.9	20.9
1996	26.9	24.0	40.6	41.4	22.9	29.6	21.1	24.8	20.4	25.0	20.3	21.2
1997	27.1	23.9	40.6	42.4	23.4	30.0	21.6	26.1	20.7	24.9	20.7	21.6
1998	27.8	24.3	41.7	44.1	23.6	31.0	21.4	26.6	20.9	24.7	20.8	21.5
1999	28.1	24.3	42.4	44.3	23.5	30.6	21.5	25.9	21.6	23.7	21.1	22.0
2000	28.7	25.2	44.7	45.7	24.9	31.5	23.5	26.7	22.0	24.9	22.2	23.4
2001	29.3	26.2	45.7	47.5	23.4	31.9	23.9	26.3	22.0	25.9	22.3	23.3
2002	28.5	26.6	44.8	45.3	22.6	29.9	22.9	26.3	22.4	25.1	22.1	22.6
2003	28.3	27.6	45.1	44.4	22.9	30.1	23.6	26.8	21.8	25.1	21.8	22.1
2004	28.9	27.3	45.3	44.9	23.0	29.9	23.4	27.2	21.9	25.6	21.9	22.4
2005	27.7	26.0	43.9	43.5	21.8	28.5	22.2	25.9	20.7	24.3	20.7	21.2

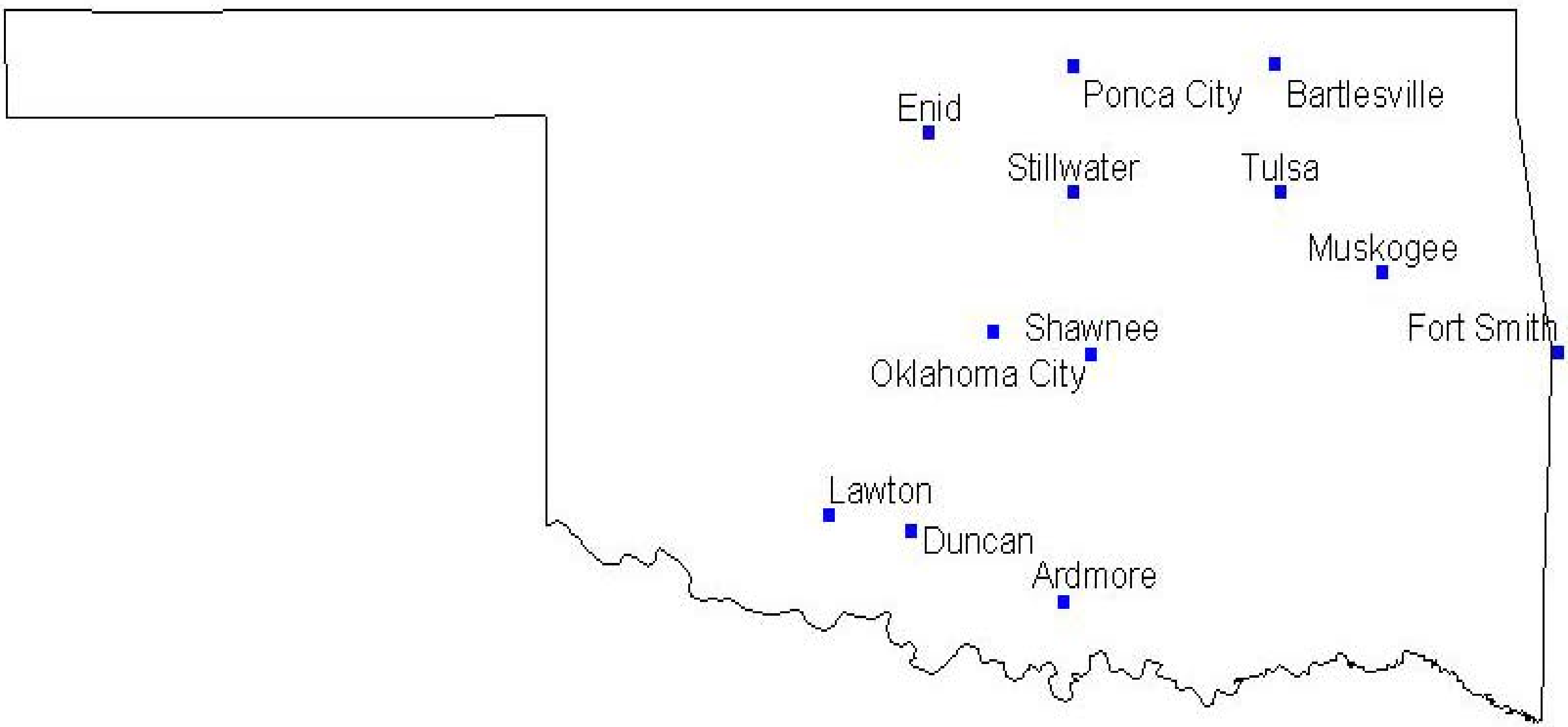

Figure III-1. Map of Urban Centers

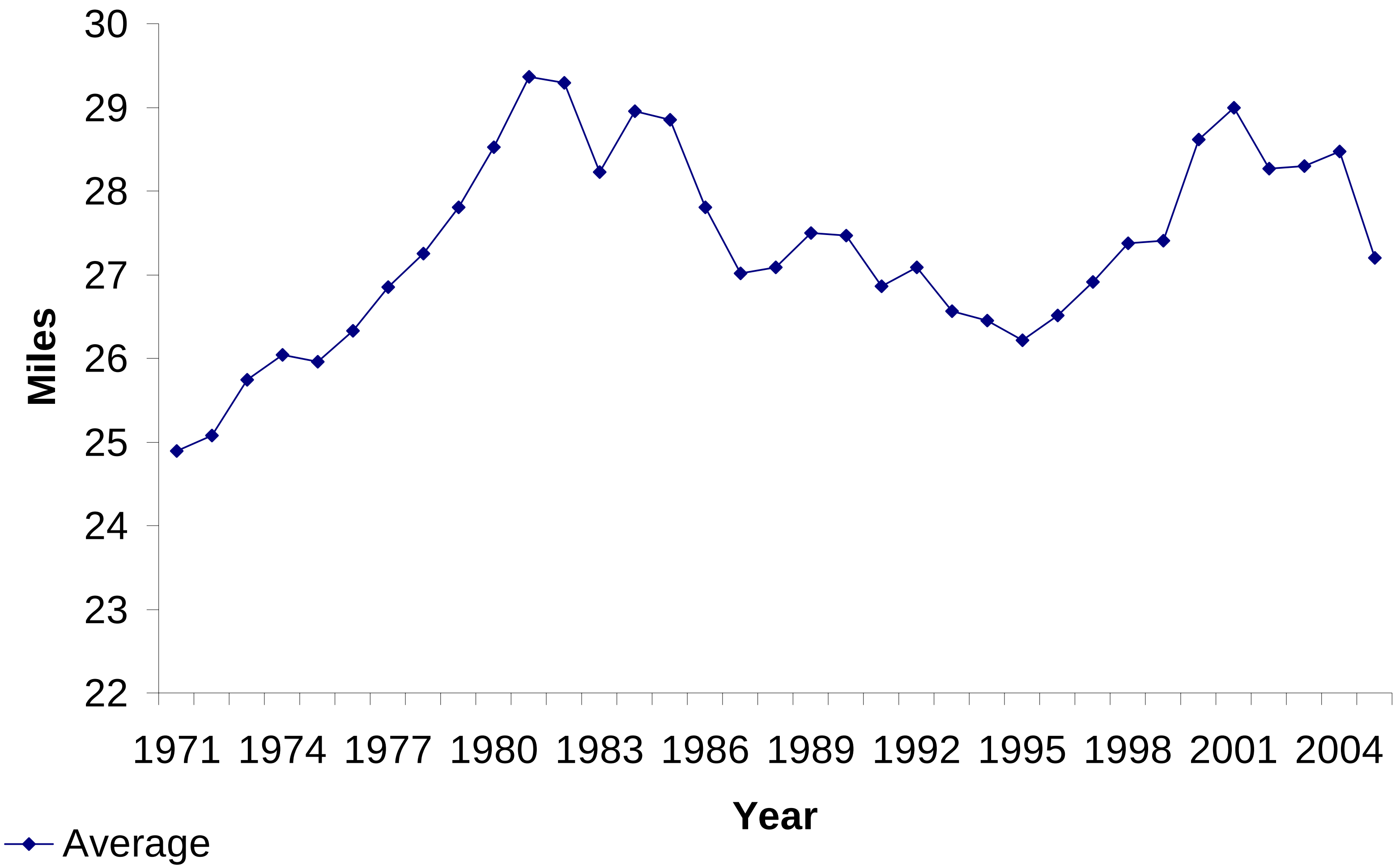

Figure III-2. Average Distance in Miles for the Twelve Cities

VITA

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Master of Science

Thesis: INFLUENCE OF NONAGRICULTURAL VALUES ON AGRICULTURAL LAND PRICES

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Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: INFLUENCE OF NONAGRICULTURAL VALUES ON AGRICULTURAL LAND PRICES?

Pages in Study: 75 Candidate for the Degree of Masters of Science

Major Field Name: Agricultural Economics

Scope and Method of Study: The purpose of this study was to determine non agricultural and agricultural influences on agricultural land values. In the first paper, recreation and urban influence were estimated using five years with models for all transaction acres, greater than or equal to eighty acres, and less than eighty acres. In the second paper, models were estimated using 35 years of data and dividing the state into a western and an eastern section. The third paper used a linear plateau model. Variables such as deer harvest, population, income, and distance to urban centers in Oklahoma and Arkansas were used along with land use variables (cropland, pasture land, irrigated cropland, timber, waste, water, and recreation acres) in all models.

Findings and Conclusions: Agricultural factors continue to be important in explaining farmland values. Urban conversion values are increasing in importance and recreation does have some impact.

Advisor's Approval: Dr. Damona Doye